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RECLAMATION OF ALKALINE ASH PILES

by

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Contract No. J-2-141-EPA

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16. ABSTRACT

The objective of this study was to develop methods for reclaiming ash disposal piles for the ultimate use as agricultural or forest lands. The ashes studied were strongly alkaline and contained considerable amounts of salts and toxic boron. The ashes were produced from burning bituminous coal which produced aluminum-silicon ashes and from lignite which produced calcium-sulphate ashes.

This report is the second describing this project. The first report contained a review of literature and described the ash analysis; the greenhouse pot studies; the preparation of the ash disposal piles; and the early grass, legume, and tree field studies. It was published as EPA report 600/7-79-128, "Reclamation of Alkaline Ash Piles and Protection of Their Environment Against Dusting," by Wladyslaw Wysocki, July 1979. This second report describes the remainder of the field studies.

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of solid and hazardous wastes. These materials, if improperly dealt with, can threaten both public health and the environment. Abandoned waste sites and accidental releases of toxic and hazardous substances to the environment also have important environmental and public health implications. The Hazardous Waste Engineering Research Laboratory assists in providing an authoritative and defensible engineering basis for assessing and solving these problems. Its products support the policies, programs and regulations of the Environmental Protection Agency, the permitting and other responsibilities of State and local governments and the needs of both large and small businesses in handling their wastes responsibly and economically.

In this report, methods for the reclamation of solid waste ash ponds are discussed. The ashes from a powerplant burning bituminous coal and from one burning lignite were studied. Based on these findings, recommendations for the reclamation of alkaline ash are made. The results should be of interest to persons responsible for the stabilization and reclamation of ash disposal areas. For further information, please contact the Land Pollution Control Division of the Hazardous Waste Engineering Research Laboratory.

David G. Stephan, Director
Hazardous Waste Engineering Research Laboratory

SCIENTIFIC ACTIVITIES OVERSEAS

(Special Foreign Currency Program)

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Scientific Activities Overseas not only supplement and complement the domestic mission of EPA, but also serve to carry out the mandate of section 102 [2(E)] of the National Environmental Policy Act to "recognize the worldwide and long-range character of environmental problems, and where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment."

This study has been funded from Public Law 480. Excess foreign currency money is available to the United States in local currency in a number of countries, including Poland, as a result of a trade for U.S. commodities. Poland has been known for its extensive mining interests, its environmental concern, and its trained and experienced engineers and scientists in this important energy area.

ABSTRACT

The objective of this study was to develop methods for reclaiming ash disposal piles for the ultimate use as agricultural or forest lands. The ashes studied were strongly alkaline and contained considerable amounts of salts and toxic boron. The ashes were produced from burning bituminous coal which produced aluminum-silicon ashes and from lignite which produced calcium-sulphate ashes.

In 1974, the ashes were analyzed and greenhouse pot experiments on neutralization and fertilization were carried out to determine potential cultivation techniques. Results of these experiments were used as a basis for field experiments that tested the effectiveness of neutralization, ash pile preparation, and fertilization treatments to form soils on ash piles. Pioneer plants used included grasses, legumes, trees, shrubs, and tree cuttings. In 1981, cereal crops were seeded over the areas previously cultivated with grasses and legumes.

The experiments were carried out to assess the growth, health, and yields of plants, as well as their suitability for human and animal consumption. Systematic laboratory analyses of soil composition and properties were made, and the process of soil formation was observed.

This report is the second describing this project. The first report contained a review of literature and described the ash analysis; the greenhouse pot studies; the preparation of the ash disposal piles; and the early grass, legume, and tree field studies. It was published as EPA report 600/7-79-128, "Reclamation of Alkaline Ash Piles and Protection of Their Environment Against Dusting," by Wladyslaw Wysocki, July 1979. This second report describes the remainder of the field studies.

This report was submitted in fulfillment of Contract J-2-141-EPA between the U.S. Environmental Protection Agency and Poltegor, the Central Research and Design Institute for Open-pit Mining, Wroclaw, Poland. The research was conducted between 1974 and 1982.

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SECTION 1

INTRODUCTION

In 1978, Polish powerplants produced 23.4 million metric tons (t) of wastes (16.9 million metric tons of fly ash and 6.5 million metric tons of slag), of which 14.2 million metric tons was dumped on waste disposal sites. At the average disposal height of 20 cm, an ash bulk density of 0.8 t/m^3, and an area utilization coefficient of 0.7, waste disposal sites occupy an area of almost 130 ha/year.

In 1976, 80 percent of the 37.0 million metric tons of fly ash and 20.0 million metric tons of slags produced in the United States was dumped on waste disposal sites. Based on the same assumptions, waste disposal areas occupied would be 300 ha/year. In both countries, production of wastes tends to increase.

Powerplant waste disposal sites not only decrease the areas of cultivated soil, but also are noxious to the environment in the radius of at least several hundred meters as a result of fugitive dust, etc. This noxious aspect increases the impact on the environment to areas many times greater than those calculated above.

Waste disposal pollutes the soil, atmosphere, and water. Soil exposed to fugitive dust becomes degraded by enrichment of undesirable mineral components and radioactive substances, by alkalization, by filling of soil pores by fine fractions (sludge), and by changes in the water-air properties of the soil. The quality of the atmosphere is lowered by the emission of dust and harmful gaseous substances. Surface and ground waters are polluted chemically and physically, and hydrological balances are changed by intakes and discharges due to the partition of water.

The purpose of this research was to develop methods to neutralize these negative influences and to produce an area on the surface of the disposal site that could be utilized in a productive manner. The ultimate usage of the site must be based on the following factors:

- Economical and social needs of the region
- Properties of disposed wastes
- Climatic conditions of the region

Two ash disposal sites were selected for study. One contained ash from bituminous coal and the other contained ash from lignite. The ashes were analyzed, and a greenhouse pot experiment was conducted to determine the best treatments to be evaluated on the actual site. A series of plots were established at each site, and various neutralization and fertilization treatments were applied to determine those that were best for the establishment of grasses, legumes, trees and shrubs. After a few years of growth by the grasses and legumes, these plots were planted with a cereal crop. Throughout the course of the study data were collected on 1) climatic conditions; 2) plant growth, production, and health; and 3) soil and ash characteristics. This report describes these findings and presents recommendations for the establishment of vegetation on ash piles.

SECTION 2

CONCLUSIONS

The conclusions presented here were based on vegetation experiments carried out in greenhouses and in the field and on laboratory analyses carried out in the years 1974-1981. The ashes were produced from burning bituminous coal (Halemba powerplant) and lignite (Konin powerplant) and were transported onto disposal sites by hydraulic methods. Their characteristics (after dewatering) were as follows:

- Alkaline with a pH in the range of 8.0 to 10.0.
- Salinity within the range of 0.3 to 2.0 percent as NaCl.
- Soluble boron content within the range of 0.4 to 50 ppm.
- Ionizing gamma radiation not exceeding 50 picocuries per 1 g of dry mass.
- High content of K_20 (7 to 33 mg/100 g) and low levels of N and P_20_5.
- $CaCo_3$ content ranging from 2.5 to 34 percent.
- Grain-size composition of clayey sand or silty sand.
- Mullite mineralogical composition (silicon-aluminum ashes) for bituminous coal and calcite or anhydrite (calcium-sulphate ashes) for lignite.

Field experiments were carried out in moderate climate (transient from oceanic to continental climate) during 1975-81:

- The average annual precipitation was 596 mm at Konin and 822 mm at Halemba.
- Average annual temperature was +8°C; the amplitude ranged from -18°C to +33°C.
- The average annual cloud cover was 75 percent.
- The average wind velocity was 2.6 m/s.

- Dust fallout ranged from 187 to 414 metric tons (t)/km^2 per year
- The 30-minute concentration of SO_2 in the air was up to 1.3 mg/dm^3; and F_2 was up to 0.2 mg/m^3.

The conclusions reached during this study are as follows:

1) Properties and reclamation potential of ash piles are influenced by:
    - Type and quality of fuel (coal) and gangue burned by a powerplant
    - The method of deslagging and ash removal
    - The method of transportation and waste disposal
    - Age of the disposal site (degree of weathering)
    - Climatic conditions, including the amount and distribution of atmospheric precipitation and temperature during the vegetation season
    - Air pollution.
2) Investigations of agricultural and forest reclamation were performed on alkaline ash piles from bituminous coal (Halemba powerplant) and lignite (Konin powerplant). The results can be accepted as typical for ashes characterized by the following features:
    - Originating from bituminous coal or from lignite
    - Hydraulically transported to surface sedimentation basins
    - Alkaline, i.e., pH ranging from 8.0 to 10.0
    - Salinity not exceeding 2 percent (by weight) as NaCl
    - Soluble boron up to 50 ppm
    - Ionizing gamma radiation not exceeding 150 picocuries per 1 g of dry mass.
3) The chemical and mineralogical composition and physicochemical properties of ashes significantly affect classification of ashes with regard to their soil formation ability. Ashes produced at Halemba,

containing mullites and 21.8 to 27.5 percent Al_2O_3, are classified as aluminum-silicon ashes. Ashes produced at Konin, containing 3.25 to 34.1 percent CaO (mainly in the form of calcites) and 0.5 to 8.3 percent SO_2 (mainly in the form of anhydrites), are classified as calcium-sulphate ashes.

4) The toxicity of ashes to plant growth and thus their uselessness for cultivation of usable plants is caused mainly by:

    - Alkaline reaction (pH 9.0 to 12.8)
    - Salinity (particularly calcium-sulphate ashes) up to 2 percent converted to NaCl
    - Presence of water-soluble boron (up to 50 ppm)
    - Grain-size composition of sandy-clayey character, which produces unfavorable soil-water-air properties
    - Chemical composition of the ash, which causes some nutritive components not to be available to plants
    - Blue-gray color (silicon-aluminum ashes) and cream-white color (calcium-sulphate ashes), which are not observed in natural soils and which cause high soil temperatures.

5) The hydraulic transport and dumping of ash lower its pH to 8.0 to [illegible]5 as a result of being mixed with water. Hydraulic dumping with no water recycle is more favorable for reclamation because it provides a more intensive washing of contaminants from the ash mass; however, it can also create a more serious surface water pollution problem. During dumping by the hydraulic method, calcium oxides, magnesium oxides, and sulphur oxides are converted to carbonates and sulphates, which are more favorable for reclamation.

6) In the process of hydraulic transport, soluble salts are washed from the ash, which results in lower salinity (not exceeding 0.82 percent at Konin and 0.16 percent at Halemba). Boron is also washed out.

7) Field experiments were carried out in a moderate climate (transient from oceanic to continental), at relatively low precipitation at Konin (average annual from 1974 to 1980 was 596 mm) and at higher precipitation at Halemba

(average was 822 mm). A significant effect of precipitation volume on yields of pioneer plants was observed, particularly at Konin (regression coefficient $r_{xy} = 0.988$).

8) Field experiments were carried out in the vicinity of active industrial plants (including powerplants) emitting considerable masses of dust into the atmosphere (annual dust fallout 187 to 414 t/km² per year), and SO_2 (30 minutes concentration in the air over the experimental field was up to 1.3 mg/m³ at Halemba and up to 0.6 mg/dm³ at Konin), and F_2 (30 minutes concentration in the air was up to 0.2 and 0.16 mg/m³, respectively). The air pollution produced a significant negative effect on the growth, health, and yields of plants.

9) Among the pioneer plants introduced onto the disposal piles at Konin, the best results were obtained from mixture No. 3, which included:

Alfalfa (medicago sativa)	36 kg/ha
Orchard grass (Daczylis glomerata)	6 kg/ha
Total	42 kg/ha

Total hay crop yields (1975-1980) obtained from these plants were 19.46 t/ha. Other mixtures of grasses gave significantly lower yields (10.09 to 13.21 t/ha). In Halemba, differences between yields of grasses and legumes gathered from the four tested mixes were insignificant.

10) Among various neutralizing and fertilizing treatments tested, the best effects were obtained when the ash was covered with a 20-cm layer of fertile soil. Decreasing the soil layer thickness resulted in decreasing pioneer plant yields:

- At a thickness of 10 cm of fertile soil - by 5 to 18 percent on fertilized plots and by 0 to 24 percent on nonfertilized plots
- At a thickness of 5 cm of fertile soil - by 21 to 35 percent on fertilized plots, and by 17 to 35 percent on nonfertilized plots
- Without fertile soil - by 39 to 51 percent on fertilized plots, and by 43 to 44 percent on nonfertilized plots.

11) Among other treatments, the following should be emphasized:

- Amendment of low moor peat (10 t/ha)
- Amendment of farm manure to sulphate - calcium ashes at Konin (20 t/ha)
- Amendment of green manure (40 t/ha) and double mineral fertilization at Konin.

12) Discontinuation of yearly application of mineral fertilization on pioneer plants caused losses in grasses to legume plants and a decrease in hay yields (by 44 to 53 percent). The strongest reaction was observed on plots not treated with organic substances such as soil, peat, and farm manure.

13) Yields of cereals planted (winter barley) after pioneer plants did not depend on the type and mixture of pioneer plants. Yields did depend, however, on the neutralizing-fertilizing treatments applied prior to introducing pioneer plants. The best results were obtained on plots where fertile soil had been applied.

14) During 6 years of cultivating pioneer plants, a slight gradual improvement in the properties of the soil surface layer (0 to 10 cm) was observed. The symptoms were lower salinity and boron content, a slight decrease in pH, and an increase of organic matter; these effects caused changes in the soil color and improved the water and sorption capacities. Deeper layers remained toxic, and plant roots did not penetrate them.

15) The best method to reclaim ash piles is to cover them with a layer of fertile soil at least 20 cm thick. If this is done, further treatments and fertilization should be directed to the properties of the soil.

16) Hay and cereal crops gathered from ash piles can be eaten by animals and people. However, it is recommended that they be analyzed for trace elements and accumulation of radioactive elements (gamma radiation) at each site to verify their safety.

17) In forest-type reclamation, dressing pits with fertile soil plus multicomponent mineral fertilizers significantly increased survival and growth. Pits partially filled with fertile soil, bentonite, peat, and acidified sands only slightly increased survival rate of cuttings in the first years of vegetation. Influence on growth in later years was not significant.

18) When trees and shrubs planted in pits were dressed with fertile soil or neutralized ash, the plant roots very reluctantly penetrated the ash adjacent to the pits. Poor root spreading caused unsatisfactory development of roots, poor resistance to drought, and unsteadiness during strong winds.

19) Ash piles can be used for agricultural production of fodder plants and cereals after ash treatment and fertilization. Introducing usable tree and shrub species on these ashes does not appear promising because root penetration, survival, and growth, even with ash treatment and fertilization, were poor.

SECTION 3

RECOMMENDATIONS

Based on the results of this study, the following recommendations are made for reclamation of ash disposal sites:

1) For assessment of the reclamational potential of an ash disposal site, the following factors should be determined:

   - Type and quality of fuel (coal) and gangue
   - The method of preparing the fuel before burning, the method of burning in boilers, and the method of deslagging and ash removal
   - The method of transporting and disposing of the wastes at the disposal site
   - Age of the ash (degree of weathering)
   - Local climatic conditions and available local materials for treating the ashes
   - Grain-size composition of ashes (mineralogical and chemical)
   - The nutrition content (N, P_2O_5, K_2O, CaO, MgO)
   - The content of microelements necessary for plants to live and those hazardous to plants, people, and animals
   - Reaction (pH), sorption capacity
   - Salinity
   - Content of soluble boron
   - Radioactivity (content of radioactive elements and ionizing radiation).

2) Based on the intended method of reclamation and the ash quality and toxicity, neutralization (ash treament) methods should be evaluated. Characteristics of the materials to be used to neutralize (treat) and fertilize the ashes should be established.

3) The disposal site surface should be shaped to protect it against water erosion. The top surface gradient should not exceed 3 percent (1:33). Slopes should be stabilized by engineering-biological methods.

4) Hydraulic transport of ash should be encouraged, as this method washes out toxic substances (e.g., salinity, boron) and decreases the pH. Hydraulic methods of ash dumping also help to provide the desired shaping of the top surface and slopes of the disposal area. From the standpoint of ash quality, not recycling this transport water was more favorable than recycling; however, this can have unfavorable environmental effects, such as surface water degradation and large volume water withdrawal.

5) To intensify leaching of excess soluble salts (including chlorides and boron), the surface layer of the ash pile should be deeply loosened. Loosening (to the depth at least 60 cm) could be made with scarifiers, heavy plows, or explosives. Leaching can then be accelerated by sprinkler irrigation.

6) The ashes are best prepared for use in planting by neutralization and fertilization. Neutralization improves water-air and sorptive properties. Fertilization can be done using the following soil amendments:

   - Covering with fertile soil (at least 2000 m^3/ha). The effectiveness of land improvement is directly proportional to the thickness of the soil layer and to its fertility. At a thickness of more than 0.5 m, fertility of the improved pile depends almost exclusively on the properties of the soil covering the ash.

   - Mixing with farm manure applied at a rate of 40 t/ha (dry mass).

   - Mixing with green manure applied at a rate of 50 t/ha. Legume manure is desired; however, in the experiment good results were observed when green maize was applied.

   - Applying low moor peat or high moor peat at rates of 10 to 100 t/ha.

7) In pot experiments, the following acidifying materials have not proved to be effective: flowers of sulphur, sulphuric acid, gypsum, and acidic tertiary sand.

8) Fertilization prior to seeding should include nitrogen, phosphorus, and necessary microelements. Rates of NP tested in the experiment were 85 kg/ha of N in the form of ammonium nitrate and 210 to 350 kg/ha of P_3O_5 in the form of treble superphosphate.

9) After seeding, top dressing with nitrogen should be applied at a rate of 35 to 50 kg/ha of N in the form of ammonium nitrate.

10) In cultivation of pioneer grasses and legumes, soil must be systematically fed with mineral fertilizers NPK + microelements. In the experiment (in spring before vegetation season and after each swath of gathered hay), the following doses were tested:

° 135 kg/ha of N

° 60 kg/ha of P_2O_5

° 200 kg/ha of K_2O

° microelements (Zn, Mn, Cu, Co).

11) Neutralized and fertilized plots should be seeded with mixes of grasses and legumes at rates 2 or 3 times higher than those applied on natural soils. Five mixtures (combinations) of plants were tested in field experiments:

° Mix of holy clover with crown vetch (on sulphate-calcium disposals)

- Holy clover (*Onobrychis viciaefolia*)	-	280 kg/ha
- Crown vetch (*Coronilla varia*)	-	70 kg/ha
Total:	-	350 kg/ha

° Mix of melilot with alfalfa:

- White melilot (*Melilotus albus*)	-	10 kg/ha
- Alfalfa (*Medicago sativa*)	-	50 kg/ha
Total:	-	60 kg/ha

° Mix of grasses + legumes:

- Meadow fescus (*Festuca pratensis*)	- 24 kg/ha
- Orchard grass (*Dactylis glomerata*)	- 8 kg/ha
- Smooth bromegrass (*Bromus inermis*)	- 24 kg/ha
- Annual meadowgrass (*Poa pratensis*)	- 10 kg/ha
- Creeping fescus (*Festuca rubra*)	- 34 kg/ha
- Tall oat grass (*Arrhenatherum elatius*)	- 26 kg/ha
- Redtop (*Agrostis stolonifera*)	- 8 kg/ha
- White clover (*Trifolium repens*)	- 6 kg/ha
- Black medic (*Medicago lupulina*)	- 14 kg/ha
- White meliot (*Melilotus albus*) in pure component	- 6 kg/ha
Total:	- 160 kg/ha

° Mixture of alfalfa + orchard grass:

- Alfalfa (*Medicago sativa*)	- 72 kg/ha
- Orchard grass (*Dactylis glomerata*)	- 12 kg/ha
Total:	- 84 kg/ha

° White melilot (*Melilotus albus*) in pure component - 100 kg/ha

All legume seeds should be treated with nitrogen fixing bacteria. The lowest yields among the combinations presented were from the mixtures of holy clover with crown vetch (crown vetch did not germinate at all). Differences between yields of the remaining mixtures were statistically insignificant. The most aggressive was orchard grass.

12) Annual top dressing with fertilizer will produce higher yields. Total yields were 44 to 53 percent lower on unfertilized plots. Top dressing of pioneer plants caused much more intensive growth of grasses and deterioration of legumes. On plots where mineral top dressing had not been applied, grasses died out and were replaced by legumes.

13) After mineral fertilizers are sown and pioneer plants are seeded, the surfaces should be protected against secondary dusting (wind erosion) by covering them with film forming substances. Good results were obtained by covering the surface with a water solution of elastomer (latex LBSK-5545) in the volume ratio of 10:1 (seeds and fertilizers may be seeded together with the elastomer solution) at a rate of 833 dm^3/ha of latex, which forms a film 0.08 mm thick.

14) After 3 or 4 years of cultivating pioneer plants, winter cereals or spring cereals can be seeded. In the experiment, winter barley was seeded at a rate 33 percent higher than on natural soils. After pioneer plants, forecrop plots were plowed under, normal pre-seeding treatments took place, and mineral fertilization was applied (100 kg/ha of K_2O and 90 kg/ha of P_2O_5).

In spring, plots were fertilized three times with nitrogen, each time at a dose of 45 kg/ha of N. Weeds that remain after cultivation of pioneer plants must be removed.

15) Cultivation of root crops is not recommended as this requires loosening soil, which promotes wind erosion.

16) First crops of pioneer plants and destination plants should be tested in the laboratory to make sure they do not contain excessive amounts of toxic or radioactive substances.

17) Reclamation through planting trees for lumber is not recommended because of the difficult soil conditions. The following tree species may be planted on protected belts or slopes:

- Locust tree (*Robinia pseudoaccacia*)
- Pea shrub (*Caragana arborescens*)
- Sea buckthorn (*Hippophae rhamnoides*)
- Gray alder (*Alnus incana*).

Based on the criteria of survival rate and height of growth, the following species proved to be of little use: poplars x *robusta*, T. x *Nieklan* and T. x *Simona* (*Populus* x *robusta*, P. x *simonii*), white birch (*Betula verrucosa*) on aluminum-silicon ashes; black alder (*Alnus glutinosa*), European larch (*Larix decidua*) on sulphate-calcium ashes; willow (*Salix* sp.) on aluminum-silicon ashes. Poplar cuttings were growing well only on areas covered with a 20-cm layer of fertile soil.

18) Planting trees in pits (0.5 m x 0.5 m x 0.5 m to 0.7 m x 0.7 m x 0.7 m) filled with fertile soil plus mineral fertilizers (N and P) is recommended. Partial dressing of the pits with fertile soil or peat, bentonite, and acidic sand had very little positive effects on the survival rate and growth of cuttings in the first year of vegetation.

19) Selection of pioneer plants should be governed by the region of the disposal site. Selection of plants will be wider for regions where the amount of precipitation is greater. In areas where precipitation in the spring-summer period does not exceed 150 mm, artificial watering would be necessary to establish vegetation.

SECTION 4

STATE OF THE ART

FORMATION OF POWER PLANT WASTES

Bituminous coal and lignite are the two fundamental sources of energy in Poland. Production of coal has been increasing, e.g., 104 million metric tons of bituminous coal and 9.3 million metric tons of lignite in 1960 versus 193 and 41 million metric tons, respectively, in 1978. Between 1960 and 1970, lignite mining by open-pit methods was developing rapidly (the share of energy produced from lignite increased from 5.8 to 37.9 percent), and the production was almost exclusively intended for power-plants. Coal is also the fundamental source of energy in other countries. In the United States, 403 million tons, i.e., 80 percent, of 517 million tons of coal produced in 1980 was utilized in power plants.[1]

Burning of coal in traditional power plants, heating plants, and thermal electric power stations is accompanied by formation of waste byproducts (Figure 1). The main factors determining the composition and properties of ashes are the original composition of the coal, its impurities, and the devices and systems used for its utilization.

Coal is processed in central plants or in mills installed at individual electric steam generating facilities. The coal fineness depends on the type of supplied coal, the kind and quantity of gangue, and the type of milling machines. The processing affects the content of combustible parts in the ash and slag, i.e., so-called roasting losses. Experiments have shown that the better the coal is pulverized, the smaller the roasting losses.[2] The content of noncombustible parts in ash can vary from 5 to 40 percent, depending on the degree of coal pulverization in the mills. The longer a mill operates, the coarser the grains become until maintenance is performed on the milling equipment.

The chemical composition and grain-size of ashes are dependent on the method of coal burning, the atmosphere in the furnace fired with pulverized coal, and the proper control of the combustion process. Pulverized coal is burned in chambers with a temperature of 1400° to 1500°C; however, because each coal particle is not in the furnace core, some particles reach different temperatures, which affect the chemical-mineralogical composition of the ashes and slags.

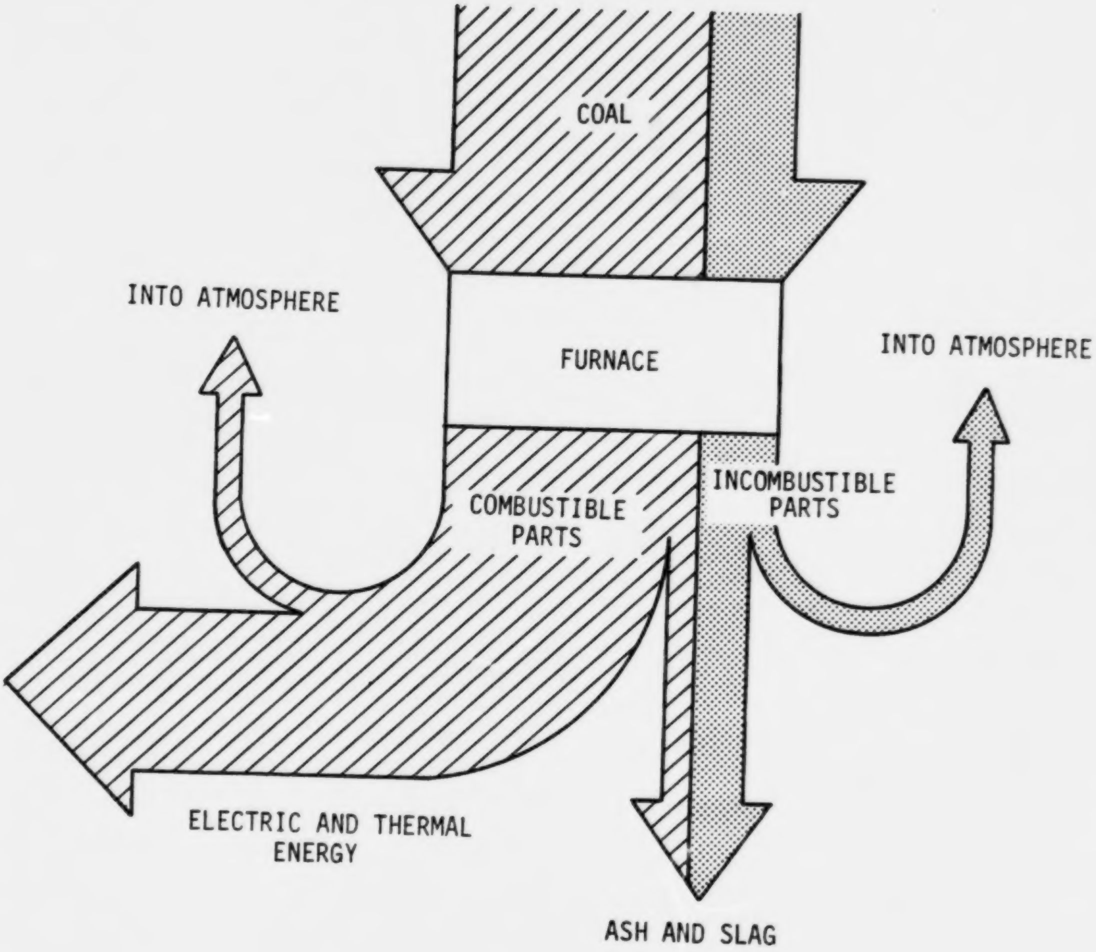

COAL
INTO ATMOSPHERE
FURNACE
INTO ATMOSPHERE
COMBUSTIBLE PARTS
INCOMBUSTIBLE PARTS
ELECTRIC AND THERMAL ENERGY
ASH AND SLAG

Figure 1. Production of furnace wastes.

Another fundamental factor affecting the quality of wastes is the dust-collection system. In Poland, electrofilters are used. Their efficiency varies from 97 to 99 percent, and dust with a fineness of 5 to 20 micrometers is collected. Specific surface area does not exceed 3000 cm^2/g.

Ash content in coal varies between 20 and 25 percent.[3] Because wastes also contain noncombusted coal particles, the solid waste bulk is usually about 30 percent of the burned fuel. Similar values are obtained with lignite.

In 1978, the production of fly ash and boiler and furnace slags in Poland was 983 t/MW of installed capacity. Based on a powerplant life of 30 years, approximately 29.5 thousand t/MW will be produced.

Not all wastes will be dumped on waste disposal sites. In 1978, 39.4 percent of ash wastes produced in Poland were used for industry, agriculture, transportation, mining, building industry, etc. The rest was dumped on disposal piles located in the vicinity of the powerplants.

TRANSPORT OF ASHES

The moisture content of ash at the furnace outlet or dust collecting plant outlet varies from 0 to 3 percent, and its grain-size composition and structure are very powdery, which makes it conducive to dusting during belt and road transport. One means of controlling dusting is the use of air-tight transport systems. Consolidation of the ash is recommended for transport. This is done by increasing the moisture content to 20 to 50 percent, which significantly increases the weight of the waste transported.

The ash wastes are transported to disposal sites by the following methods:

- Dry methods (pneumatic conveying, belt transport, road transport, and mixed types of transports)
- Wet methods (hydraulic transport).

A rapid development of wet methods was observed in the fifties with the increased consumption of high-ash fuels and increased powerplant capacity. Wet transport was chosen for its reliability, simplicity, and low operational costs. It consists of gravitational or pressure transport of ash and slag mixture in pipelines to wet disposal sites, i.e., ash ponds.

Wet disposal can take place in an open or closed cycle. In open cycle, the water is used once. After the ash is precipitated in the disposal site, the water is discharged into surface water courses. Open cycles were used at older disposal sites or at sites where larger volumes of water were available. In closed cycle systems, the water is recycled to the pumping station and then back to the ash transport system. In the closed cycle, losses due to evaporation, percolation, and leakage are made up with additional water. For example, the Halemba Power Plant, which uses 3000 metric tons of bituminous coal per day with an ash content up to 40 percent (average 25 percent) is operated in a closed cycle. A total of 11,500 m^3/24 hours of water is pumped for ash removal needs. The losses are as follows:

Evaporation, percolation, leakage	-	1100 m^3/24 hours
Cooling of ashes and slags	-	300 m^3/24 hours
Total:	-	1400 m^3/24 hours

Closed cycles require higher investment costs and more complicated attendance, but they do not pollute surface and groundwaters with discharge of sediment waters and they provide a water savings, which is particularly important in regions with water shortages.

DISPOSING OF WASTES

Because ashes have favorable strength properties, dry disposal does not create greater problems than wet disposal as long as the proper technology is used. For agricultural and forest type reclamation, the top surface and slopes of the disposal area must be inclined properly to enable cultivation, introduction of plants, and control of water.

In wet disposal, ash pulp is discharged at fixed points on one side of the area (opposite the overflow structure) or into a system of surrounding ditches on all sides of the sedimentation pond. Supernatant waters are drained through overflow pipes. Wet disposal ponds are usually divided into three sections for alternate drying and so that dike height can be raised on individual sections. The sedimentation pond and sections are embanked with dikes (3 to 10 m high) built of impermeable soils. Dikes are usually raised by using previously settled ashes to prolong the operational life of the sedimentation pond. Dikes are raised several times and can reach a height of more than 20 m.

ASH PROPERTIES

Grain-size composition of bottom ash is highly heterogeneous and, using the terminology used in soils characterization, varies from sand to clay. The composition depends on the type of furnace, the treatment received by the coal, and the technology of ash removal, transport, and disposal.

About 25 to 74 percent of the particles in slags have diameters larger than 1 mm, and the sand fraction (0.1 - 1 mm) ranges from 20 to 70 percent (Table 1). Boiler slag and bottom ash in the U.S.A. are of similar composition.[4] This composition results in a high porosity and low water and sorption capacities. Therefore, they are of little use in the soil formation process.

Grain-size composition of fly ash depends mainly on the method of ash removal. The lowest variations in grain-size distribution are observed in the finest ashes (in which the content of fractions below 0.074 mm exceed 90 percent) from electrofilter chutes just before the stack.[5] Fly ash from Polish powerplants (Table 1) can be classified as silts, silt loams, and sandy loams, using the U.S. Department of Agriculture soil classification. Such formations are more favorable for vegetation of plants because of their slightly higher water and sorption capacities.

Dumping by hydraulic methods results in fractionation of ashes depending on the distance from the pulp outlet. The greater the distance is from the pulp discharge point, the greater the share of fine fractions. Layered texture is characteristic. The thickness of layers varies from 0.5 to 12 cm. Macroscopic differences between individual layers include not only granulation but also color and chemical and mineralogical composition. Ashes filling the sedimentation pond form mainly loose sediment. Only surface layers can be built of cemented ashes,[6] whose firmness is similar to mudstone layers (up to 1 cm thick) or sandstone layers (6 to 12 cm thick).

Specific gravity of bituminous coal ash varies from 2.2 to 2.8. Ash from the Halemba Power Plant has low specific gravity (2.15 to 2.50), which indicates a considerable content of noncombusted coal. Specific gravity of lignite ash varies from 2.31 to 2.72 (Konin Power Plant).

Bulk density of ashes tested by the author[7] was always less than 1; e.g., 0.56 to 0.97 for bituminous coal ash (Halemba), and 0.54 to 0.74 for lignite ash (Konin). Total porosity of ash sampled from sedimentation ponds exceeded 70 percent, and the capillary porosity was high. The porosity of ashes from Konin reached 74 percent.[7]

TABLE 1. GRAIN-SIZE COMPOSITION OF SOLID WASTES
(percent)

Origin of wastes	Skeletal (more than 1 mm)	Diameters, in mm 1-0.5	0.5--0.25	0.25--0.1	0.1--0.05	0.05--0.02	0.02--0.006	0.006--0.002	below -0.002	Comparable soil
Bituminous coal wastes										
Slag from the power-plant ROW (Average)	44.7	31.3	15.7	8.0	21	12	7	2	3	Gravelly sand
(Range)	25-74	7-45	13-18	0.25-29	29-23	8-19	2-14	1-2	2-4	
Ash from the power-plant ROW (Average)	0.0	0.5	2.0	17.9	14	40	22	2	2	Silt loam
(Range)	0.0	0.2-1	1-3	17-19	12-16	39-44	19-26	2	1-2	
Ash from the power-plant Halemba Electrofilters (Average)	0.0	0.2	1.8	9.0	26	33	22	5	2	Silt
Wet disposal (Average)	0.0	6.5	14.8	18.7	28	20	8	2	2	Silt
(Range)	0.5-3	9.5-26	1-36	8-50	4-30	6-33	2-12	0-3	1-5	
Lignite wastes										
Ash from the power-plant Turow Electrofilters (Average)	0.0	3.2	8.7	19.6	15	21	21	4	7	Sandy loam
Disposal (Average)	0.0	6.5	10.9	17.9	25	31	3	1	5	Silt loam
Ash from the power-plant Konin Electrofilters (Average)	0.0	0.8	4.1	15.1	23	49	1	1	6	Plain dust silt loam
Disposal (Average)	0.0	2.8	19.4	39.8	21	5	5	3	4	Sand
(Range)	0-3	0-14	10-37	24-41	10-25	4-12	4-12	1-4	1-8	

Soil-water properties of ash are presented in Table 2. The ash can be compared to light clayey sands and, in some cases, to heavy clays and silts. The high silt content, high porosity, and capillary water capacity cause the material to drain easily. According to Maly,[8] in Czechoslovakia the capillary rise of water in lignite ash reaches 6 m, which results in high water losses to evaporation. As a result, surface layers are exposed to high variations of moisture and even complete drying. This characteristic causes the material to be subject to wind and water erosion and creates a condition unfavorable to plants (particularly plants with shallow root systems).

Mineralogical composition of ashes and slags is dependent on the type of burned coal, type and amount of gangue, the method of burning and ash removal methods. Rehsi[9] distinguishes four groups of minerals of ash that can be produced:

- Claystone group (e.g., kaolinite, illite)
- Carbonate group (e.g., calcite, siderite)
- Sulphur group (e.g., pyrite, marcasite)
- Group of other minerals (e.g., quartz, apatite, feldspar)

In high furnace temperatures, the minerals produced include mullite, magnesite, hematite, quartz, and glass.

Bituminous coal ash from the power plant at Halemba[7], tested in X-ray apparatus, showed silicon as their main crystalline component (Table 3). Considerable amounts of gypsum ($CaSO_4.2H_2O$) and mullite ($3Al_2O_3.2SiO_2$) have also been found in the ash, with magnetite (Fe_3O_4) and hematite (Fe_2O_3) occurring in smaller quantities. A wide broadened diffraction band within the range of 4° to 20° indicated the presence of amorphous substance (glaze), consisting mainly of silicates, and trace amounts of quartz. The silica glaze occurs in spheres that are generally colorless and range in diameter from 20 to 60 micrometers. Mullite grains are fine, and either square in the cross section is (up to 15 micrometers) elongated, stick-like, or pin-like.

Quartz is the main crystalline component of ashes produced from burning lignite in Konin.[7] X-ray tests showed considerable amounts of anhydrite ($CaSO_4$) and CaO, with lesser quantities of hematite and magnetite. Diffractiograms of samples within the range of 4° to 10° indicate the presence of an amorphous substance, which is very distinctly divided into two maxima (9.5 and 7.4 A). This may be a partial crystallization of a glassy substance, which leads to formation of girolite-type structures or

TABLE 2. SOIL WATER PROPERTIES OF ASH AND TREATED ASH[a]
(sampled from depth 0-10 cm)

Combination	Treatment	Total porosity, percent Ash from		Capillary water capacity, percent of volume Ash from		Field water capacity, percent of volume Ash from	
		Bituminous (Halemba)	Lignite (Konin)	Bituminous (Halemba)	Lignite (Konin)	Bituminous (Halemba)	Lignite (Konin)
A	Fertile soil + NP	63.7	45.1	49.2	29.5	21.2	16.7
B	Ash + fertile soil 1:1 + NPK	70.6	47.4	50.5	30.8	19.0	20.3
C	Ash + fertile soil 3:1 + NPK	61.2	53.6	53.9	41.8	20.3	17.3
D	Ash + bentonite 100 t/ha + NPK	62.8	ND	51.7	ND	22.1	ND
	Ash + tertiary sand 3:1 + NPK	ND[b]	62.8	ND	37.8	ND	19.2
E	Ash + low peat + NPK	68.1	ND	57.6	ND	27.6	ND
F	Ash + high peat + NPK	66.9	73.8	52.2	55.9	24.3	ND
G	Ash + farm manure + NPK	66.1	72.4	56.3	53.6	26.1	ND
H	Ash + N_2PK	67.5	73.3	57.3	52.9	31.6	ND
I	Ash + NPK	64.0	78.1	58.1	55.9	29.2	42.9
0	Pure ash (control)	67.1	73.7	56.9	56.3	23.0	44.2

[a] Source: Reference 7.

[b] ND - no data.

TABLE 3. MINERALOGICAL COMPOSITION OF FLY ASH IN POLAND[a]

Component	Bituminous coal ash (Halemba)		Lignite ash (Konin)	
	Fresh fly ash from electro-filters	Ash from disposal site	Fresh fly ash from electro-filters	Ash from disposal site
Quartz (SiO_2)	+++	+++	+++	+++
Gypsum ($CaSO_4.2H_2O$)	+	+	-	-
Anhydrite ($CaCO_4$)	-	-	++	+
Calcium oxide (CaO)	-	-	++	+
Calcite ($CaCO_3$)	-	-	-	++
Xonotlite ($5CaSiO_3.2H_2O$)	-	-	-	+
Girolite ($2CaO.3SiO_2.2H_2O$) (Ca_2SiO_4)	-	-	-	+
Magnetite (Fe_2SO_4)	+	+	+	+
Hematite (Fe_2O_3)	+	+	+	+
Mullite ($3AL_2O_3.2SiO_2$)	++	++	-	-
Amorphous substance	+++	+++	++	++

[a] Reference 7.

+ Small quantities detected
++ Moderate quantities detected
+++ Large quantities detected
- Not detected

other hydrated calcium silicate. Microscopic analysis proved the presence of quartz, glaze, and CaO and lesser quantities of carbonates, calcium sulphates, and nontransparent spherical forms. A considerable share are isomeric colorless, cream color, or brown forms, inside which a black nontransparent substance is dissipated. The particle dimensions of the glaze are 20 to 50 micrometers.

The simple structure of individual ash grains produced from bituminous coal results in their having poor sorptive capacity. Calcium-sulphate ashes produced from lignite burned in Konin are more favorable in this respect as they include gypsum and anhydrite, which have a much more complicated structure. A comparison of data from Table 3 compared with data from Table 4 shows the similarity of ashes from Halemba and ashes from the United States.

Chemical composition of ashes and slags is dependent on the type of coal burned, the share of gangue, and the fractions created during removal and disposal of the ash. The dividing of the ash into fractions is greater when hydraulic disposal is used. According to Hycnar,[10] at one of Halemba's Power Plant disposal ponds, the composition from the discharge zone to the overall zone changed as follows:

SiO_2 from about 47 to about 49 percent

Al_2I_3 from about 20 to about 27 percent

Na_2O from about 0.5 to about 0.7 percent

K_2O from about 2.5 to about 3.3 percent

P_2O from about 0.42 to about 0.45 percent

Fe_2O_3 from about 4 to about 10 percent

MnO from about 0.09 to about 0.19 percent

CaO from about 2.5 to about 4.5 percent

MgO from about 2.0 to about 3.1 percent

S_{total} from about 0.12 to about 0.25 percent

Chemical composition of ashes from burning Polish coal are presented in Table 5. The ashes were divided into the following groups, based on their composition:

TABLE 4. MINERALOGICAL COMPOSITION OF ASHES[a]
(percent)

Component	Origin of ashes				
	Great Britain	United States	Japan	Yugoslavia	
				Kolubara	Kostolac
Quartz	1.0-6.5	0-4	5.4-11.8	3.2	5.5
Mullite	9.0-35.0	0-16	8.0-18.0	19.0	10.2
Magnetite	below 5.0	0-30		6.5	5.5
Hematite	below 5.0	1-8	0.5-5.3	2.0	2.5
Glaze	50-90	50-90	69-84	53.6	58.0
Corundum				1.0	2.2
Rutile				traces	0.4
Geothite				2.5	1.0
Pyrite				traces	-
Free CaO				2.7	3.5
Calcite				1.0	1.0
Anhydrite				2.1	2.2
Periclase				1.9	2.0

[a] References 11, 12.

TABLE 5. CHEMICAL COMPOSITION OF ASHES FROM POLISH POWER PLANTS[a]
(percent)

Component	Ash from bituminous coal		Ash from lignite (Konin)		Ash from lignite
	Fresh ash from electro-filters	Ash from wet dispoal	Fresh ash from electro-filters	Ash from wet disposal	
SiO_2	47.5-47.7	46.50-49.04	36.26-39.87	53.88-90.53	18.02-51.33
Al_2O_3	26.56-27.49	21.84-23.44	4.22-10.36	0.53-3.05	14.57-36.78
Fe_2O_3	6.45	10.05-11.20	5.75-7.70	2.65-5.65	5.36-18.10
TiO_2	1.0-1.25	0.90-1.05	1.16-1.74	0.45-0.62	-[b]
P_2O_5	0.28-0.29	0.27-0.29	0.07-0.11	0.11-0.03	-
CaO	4.21-4.41	4.96-6.55	27.94-34.13	3.25-18.23	2.26-15.77
MgO	2.49-2.69	2.38-2.55	4.78-7.28	0.00-1.58	1.40-11.32
Na_2O	0.80-0.82	0.40-0.42	0.14-0.28	0.03-0.06	-
K_2O	2.50-2.56	2.34-2.38	0.16-0.22	0.10	-
SO_3	0.40-0.57	0.53-0.65	7.79-8.20	0.48-1.32	1.37-8.31
S	0.23-0.28	0.21-0.29	3.12-3.41	0.29-0.53	-
Sintering losses	6.76-721	6.64-6.694	0.85-1.05	2.18-15.66	-

[a] References 7,17.

[b] - means no data.

- Silicate-aluminum from bituminous coal (Halemba)
- Sulphate-calcium from lignite (Konin)
- Aluminum B from lignite (Turow).

Figure 2 shows a comparison of the chemical composition of American ashes with the chemical composition of Polish ashes. Polish ashes show greater differences in the content of SiO_2 (36 to 90 percent), Al_2O_3 (0.5 to 37 percent), CaO (2.2 to 34 percent), and SO_2 (0.4 to 8.3 percent).

Lack of nitrogen is common for all ashes. They are usually rich in potassium (more than 25 mg/100 g of K_2O assimilable). The $CaCO_3$ contained in sulphate-calcium lignite ashes from Konin was also high in aluminum and silicate. The content of $CaCO_3$ varies from 2.2 to 16 percent. The Ca content is unsatisfactory in some ashes; e.g., some produced in the United States contain only 0.3 to 2.59 percent.[13]

The phosphorus content varies greatly (from 0.6 to 80 mg/100 g P_2O_5); however, the phosphorus is hard to assimilate by plants under conditions of strong alkaline reaction. According to Kolar,[14] the high content of silica may affect sorption of nutritive components under conditions of neutral or slightly acidic reaction. Sorption of $HPO_4.H_2PO_4$ is particularly strong. In this respect, neutral or slightly acidic ashes are more amenable to biological activation than alkaline ashes.

Sulphur compounds usually occur in smaller quantities (0.1 to 1.8 percent of SO_3). The content of sulphates is an important factor determining the course of soil formation processes on ash disposals.

Boron is a separate problem. The content of soluble boron is particularly high in fresh ash (Table 6). In ashes disposed of by hydraulic methods, this element is partially washed out. According to Townsend,[15] boron is the main factor limiting plant growth (along with a high concentration of salt and lack of nitrogen and available phosphorus). Townsend's experiments on the growth and development of plants at various boron concentrations showed that biological processes were significantly slowed down at 7 ppm of water-soluble boron.

Based on experiments with the growth and yields of the test plant mustard (Sinapis alba), Borokowski et al.[16] found that the toxic effect of boron is visible at a dose of 10 ppm on slightly acidic soils and at a dose below 10 ppm on soils rich in calcium. In an alkaline environment, boron can be intensively absorbed, which increases toxic effects.

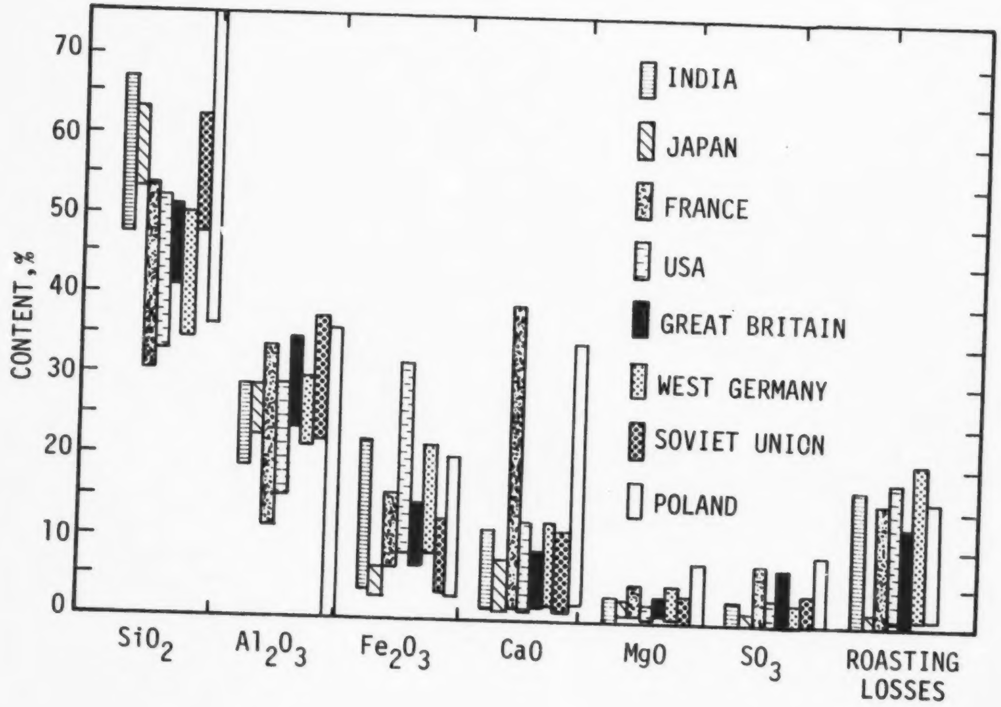


Figure 2. Chemical composition of ashes.

Source: References 7 and 9.

TABLE 6. CONTENT OF MICROELEMENTS IN POLISH AND ENGLISH ASHES[a]

Microelement	Ash from English coals	Ash from bituminous coal (Halemba)		Ash from lignite (Konin)		Culivated soil
		Fresh	From disposal	Fresh	From disposal	
Soluble Boron	3-150	9-15	0.3-2.0	8-37	3-36.5	2.5
Copper	10-50	15-27	2-26	0-5.2	0-4.5	2.5
Manganese	12-347	0-2	0-2	0.4	0-4	4.8
Molybdenum	0.7-12.8	0.8-1.4	0.2-0.26	0.24-0.28	0.01-0.22	0.2
Zinc	0-4	12.8-47	10-41.3	0-0.6	0-0.8	2.5

[a] References 7 and 18.

When analyzing ashes, one should consider the microelements cobalt, chromium, nickel, molybdenum, and selenium, which might occur in concentrations toxic to plants.

The pH of ashes is the fundamental criterion for their classification. According to Townsend and Hodgson,[16,18] pH in fresh ashes varies from 11 to 12. Based on the author's experiments,[7] the disposal of ash by hydraulic methods lowered the pH to about 9.

Acidic ashes are also produced. Ashes from lignite occurring in the Turow basin of Poland, as well as in Czechoslovakia and East Germany, have acidic or neutral pH's (from 4.9 to 7.3). This pH is probably associated with the presence of gangue in the form of acidic sands and Miocene silts.

Sorptive capacity is also significantly impacted by the gangue content of unburned coal. Sulphate calcium ashes from Konin show high sorptive capacity (40.6 to 52.4 mv/100 g) caused by montmorillonite and illite silts, whereas aluminum ashes from Turoszow (containing kaolinite silts and sands) have a sorptive capacity in the range of 7.6 to 9.4 mv/100 g.

Radioactivity of ashes is higher than that found in most natural mineral soils. The author's experiments[7] were carried out on samples taken from disposal sites situated within the range of intensive dust fallout from powerplant stacks (150 to 440 t/km^2 per year). In May 1976, after an exceptionally high dust fallout (113.6 t/km^2 per month), a higher alpha radioactivity was observed on a calcium-sulphate ash disposal site. It is probable that old disposal sites are less active. The content of ^{226}Ra in ash runoffs (8 to 62 pCi/dm^3 at Halemba and 6 to 89 pCi/dm^3 at Konin) is much higher than in surface water sources that are not impacted by such industry (0.2 to 1 pCi/dm^3).

TOXICITY

Hodgson and Cope[18] showed that toxicity of power plant wastes is usually caused by:

a) High pH

b) High concentration of salts soluble in water and in light acids

c) Presence of boron.

The author of this document believes that unfavorable vegetation conditions are also due to the unfavorable balance of soil macro- and microelements. In addition, the small grain-size composition causes cementation of fly ashes, which hinders water and air circulation and penetration of roots into the disposal area, the washing of the formed soil layer, and the removal of toxic substances down through the soil. The lack of organic substances and humus hinders soil formation processes, the accumulation of nutritive substances, and plant uptake of nutrients.

Solar radiation differs considerably on particular slopes, depending on their exposure to the sun. Gates[19] proved that photosynthesis processes in plants are not continuous when the sun shines. At high temperatures photosynthesis may stop almost completely. Wastes have different color than natural soil and may reflect rays towards plants that disturb physiological processes. These factors may cause plants that grow well on north and east slopes on natural soils to develop poorly on similarly located sites or slopes covered with wastes.

Unfavorable conditions for plant growth are reflected by unusually slow encroachment of plants on waste disposal sites. According to Hodgson and Townsend,[15] a pioneer plant on English disposal sites is the moss (*Funaria hydrometrica*), which completely covers wet surface in 6 months and is an effective protector against wind erosion. At the same time, spear-leaved orache (*Atriplex hastata*) is beginning to appear very cautiously. As weathering proceeds, higher plants begin to appear such as sorrel (*Rumex obtuifolius*), common coltsfoot (*Tussilago farfara*), white goosefoot (*Chenopodium album* and *Ch. recutilatum*), sheep sorrel (*Rumex acetosella*), mugwort (*Artemesia vulgaris*), tumble mustard (Sisimbrum albissimum), meadow clover and white clover (Trifolium pratense and T. repens), bird's-foot trefoil (Lotus corniculatus), black medic (*Medicago lupulina*), Kentucky Bluegrass (*Poa pratensis*) and annual bluegrass (*Poa annua*), and redtop (*Agrostis stolonifera*). As the toxicity decreases, forest species, e.g., white birch (*Betula verrusosa*), and willow (*Salix Sp.*) may appear. Most plants show some abnormal growth (i.e., chlorosis, maculation of leaves, growth inhibition, abnormal root system).

Based on these observations, Hodgson classified a number of plants based on their ability to tolerate soil environments formed from ashes.[15] This classification is similar to the classification for plants' sensitivity to the toxic activity of boron.

The method of vegetating ash piles by introducing plants insensitive to the toxic effects of the ash is expensive and often unsuccessful. It seems that improving the unfavorable physical and chemical properties of the ashes to obtain tolerable growth conditions is more promising. Although initial costs of this method are high, the cost of formed soil management is lower than the cost of other forms of toxic waste disposal.

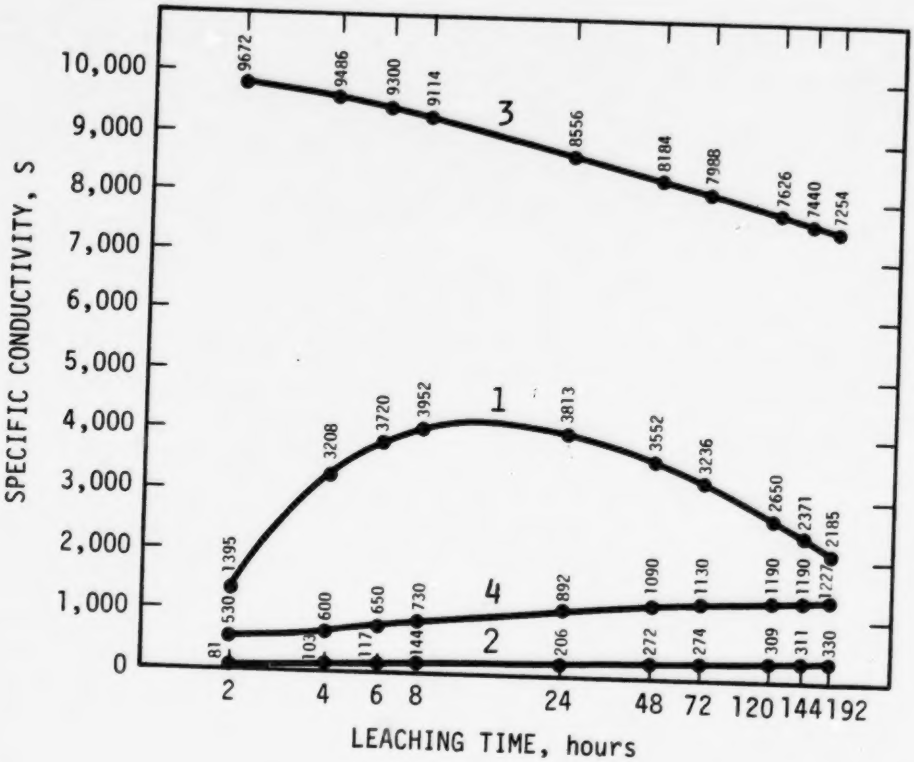
Natural succession of plants on ash disposal sites in Poland has been investigated by Greszta, Godzik and Morawski.[20,21] On a site built of bituminous coal ashes (22 to 58 ppm total boron; 69 to 226 mg/100 g of dry mass salinity; and pH 7.1 to 8.0), the first to encroach was moss (Funaria hydrometrica) and then herbaceous plants such as Canadian gleabone (Erigeron canadensis), clammy groundsel (Senecio viscosus), and chee reedgrass (Calamagrostis epigeios). The latter forms the most numerous colonies. Besides chee reedgrass, other plant species also can occur in large quantities, e.g., evening primrose (Oenothera biennis), common bentigrass (Agrostis vulgaris), clubowngrass (Corynephorus canescens), and common yarrow (Achillea millefolium). These are species growing in the poorest habitats.

English scientists[15] have tried to transform boron into nonsoluble forms or to increase its solubility and then leach it to decrease waste toxicity. The solubility of boron can be decreased by reaction with calcium to form nonsoluble calcium polyborates. Other scientists have suggested that boron can react with aluminosilicates as a substitute of aluminum ions. Small amounts of boron can be absorbed by clayey minerals (bentonite and illite). These methods have not been applied in practice, however, because they are very expensive.

Wysocki[7] investigated boron reduction by natural washing out with rainwaters and absorption by grassy plants and legumes. Results are presented later in the report.

Salinity of ashes is a serious problem that inhibits plant growth. The salinity of ash disposals has a particularly negative effect on plants during drought, when concentration of soil solutions is high. The salinity value of fresh calcium-sulphate ashes found in Konin exceeds 9 g/dm³, which at the bulk density of 0.54 g/dm³, is 1.67 percent as NaCl. The salinity of bituminous coal ashes in Halemba was 5.1 g/dm³. Hydraulic methods of dumping reduces salinity considerably; depending on the salinity in the water used for hydraulic transport of ashes, values of 1.0 to 3.5 g/dm³ NaCl can be attained.[7]

Salinity reduction was investigated by Wysocki[7] by measuring electric conductivity of water extracts from sulphate-calcium ashes (lignite) and silicate ashes (bituminous coal). (See Figure 3.) Water extracts from calcium-sulphate ashes show a gradual decrease in specific conductance from 9672 µS to 7254 µS after 8 days of contact with ashes, which would indicate quick neutralization of the solution. At first, however, water extracts from fresh silicate ashes show an increase in conductivity (after 8 hours of contact) from 1395 to 3952 µS and then a decrease, which suggests slow leaching of salts. Extracts from older ashes (from sedimentation ponds) show a gradually progressing increase in conductivity, which indicates potential hazard to the life of higher plants.



1 - FRESH SILICATE ASH (OF BITUMINOUS COAL) FROM ELECTROFILTERS

2 - SILICATE ASH (OF BITUMINOUS COAL) FROM SEDIMENTATION POND

3 - FRESH SULPHATE-CALCIUM ASH (OF LIGNITE) FROM ELECTROFILTERS

4 - SULPHATE-CALCIUM ASH (OF LIGNITE) FROM SEDIMENTATION POND

Figure 3. Specific conductivity of water extracts of ash.

Investigations carried out by Krezel et al.[22] documented difficulties in plant germination caused by salinity. Germinating seeds located 1 to 2 cm under the ash "soil" surface left their glume in soil and the root portion was lifted above the ash base. After all accumulated reserves in the grain were exhausted, the germinated plant died.

AGRICULTURAL-TYPE RECLAMATION

The most effective method of reclaiming toxic ash disposal sites, according to previous investigations, is covering them with fertile soil. An example is a site in Pietrafitta, Italy, where the surface was covered with a 0.5-m thick layer of fertile soil. At proper mineral fertilization, wheat was cultivated on this area and good crops were obtained.[23]

In the period 1965-66, Maly[8,24,25,26] carried out a series of field experiments on covering ash disposals with fertile soil 10, 30, and 50 cm thick. Three different plant mixtures were tested:

- Spring mixture (oats, spring barley, pea, and field pea) with lucerne as a companion crop
- Spring mixture with lucerne and grasses as companion crops
- Spring mixture.

The greatest yields of green mass were obtained on plots covered with a 50-cm thick layer of fertile soil (7.4 t/ha), slightly lower yields were obtained on layers 30 cm thick (5.9 t/ha), and the lowest yields were obtained on pure ash (0.6 t/ha). According to Maly, at greater thicknesses of soil, yields depend on the quality of the soil used for reclamation.

Hryncewica et al.[27] carried out experiments on cultivating usable plants on silicate-aluminum ashes (disposal in Halemba) and obtained good crops of grasses (8 to 11.5 t/ha of green mass) and spring barley (3.1 to 3.2 t/ha of grains), and satisfactory crops of fodder beets (25 to 32 t/ha of roots). The results were obtained by proper cultivation, fertilization with organic and mineral fertilizers, and irrigation.

Four-year experiments were conducted on the cultivation of a mixture of grasses with legumes (25 percent orchard grass, 20 percent Kentucky bluegrass, 20 percent creeping fescue, 10 percent redtop, 10 percent awnless bromegrass, 15 percent purple medic, and 2 percent Dutch tall oat-grass). Cultivation and fertilization treatments were:

- Plowing to the depth of 0.15 to 0.20 m
- Harrowing to break bigger clods
- Fertilization in various combinations: 100 t/ha of high moor peat, 100 t/ha of lignite, and 2 t/ha of powdery sulphur
- Mineral fertilization: 200 kg/ha N, 200 kg/ha P_2O_5, 200 kg/ha K_2O, 100 kg/ha copper sulphate, 100 kg/ha manganese sulphate, 20 kg/ha borax, 4 kg/ha ammonium molybdate, 5 kg/ha zinc sulphate, and 23.4 kg/ha ferric chloride
- Seeding (42.5 kg/ha)
- Vaccination (100 kg/ha of fertile mineral soil)
- After gathering the first swath, applying 1/2 the initial dose of mineral fertilizer.

The highest yields of hay were obtained from plots fertilized with microelements, peat, and sulphur. Lower yields were obtained from plots fertilized with high doses of nitrogen, phosphate, and potash (NPK). Amendments of peat (without sulphur) or lignite were less effective; the poorest effects were achieved when microelements only were added. Attempts to cultivate spring barley and sunflower were not successful. Positive results were observed in cultivation of such plants as rape, turnip, turnip-rooted cabbage, fodder beet, white mustard, creeping fescue, wheat, and agrimony.

Experiments carried out by Wysocki on disposals of sulphate-calcium lignite ashes and silicate-aluminum bituminous coal ashes are presented later in this report.

FOREST-TYPE RECLAMATION

Attempts to acclimatize trees and shrubs have been carried out on the bituminous coal ash disposal in Oswiecim and Halemba by Kluczynski and others.[28,29] The authors indicate unfavorable properties of the ashes, such as pH of 9 to 10, salinity, small quantities of assimilable nitrogen at a very high C and N ratio (112:1), lack of phosphorus (due to quick retardation), manganese (at at an unfavorable ratio Fe:Mn), and an excess of Ca, Na, Mg, Fe, Al, Pb, Co, Cd, As, Ba, Cu, Zn, B, and Mo. In the period 1969-72, 50 species of trees and shrubs were planted and 10 combinations of mineral and organic fertilization were applied.

Planting 1-year or 2-year cuttings produced the best results. Sowing older seeds and planting older trees produced the worst results. Cuttings took root well under conditions where shoots were strongly cut (except a few, e.g., birch). According to the author, the best trees to plant on these wastes are ninebark (*Physocarpus intermedius*), rose (*Rose rugosa*), spiraea (*Spiraea menzesii* and *S. densiflora*), Russian olive (*Elaeagnus augustifolia*), sea buckthorn (*Hippophae rhamnoides*), tamarisks (*Tamarix gallica* and *T. tetrandra*), locust tree (*Robinia psuedoacacia*), Siberian pea shrub (*Caragana arborescens*), white poplar (*Populus alba*), and sharpleaf willow (*Salix acutifolia*). An important quality of trees should be their resistance to droughts and high temperatures. Each species requires individual determination of fertilization methods and the quantity of fertilizers to apply. Fast initiation of soil formation processes may be very important; this can be achieved by fieldcrop production techniques and cultivation of plants having a great mass of root systems, developed microrhiza, and bacteria flora (nitrogen fixing bacteria.)

Maciak et al.[30] carried out experiments on the cultivation of several varieties of basket willow on sulphate-calcium ashes in Konin. Mineral fertilizer has been applied and some of the pits (average diameter of 40 cm and average depth of 15 cm) have been dressed with 0.5 kg of high moor peat or 0.5 kg of lignite. After 3 years, the number of plants decreased by 30 percent. Ninteen percent showed very poor growth. The prevailing group among those that survived was perennial truncated plants, and the poorest group was cuttings. In another experiment, 2-year-old nursery cuttings of trees and shrubs were planted. During a 3-year period, drying out of poorly rooted plants was observed. After 3 years, 6 of the 11 planted species survived. After 7 years, the best vitality was shown by Berlin and Korean poplars; slightly lower vitality was shown by white poplar, two varieties of willows, European ash, gray alder, olive, and tamarisk. Poplar roots reached lengths up to 280 cm, but their depth was only 10 to 30 cm. A decisive factor for growing trees and shrubs is the thickness of the crumbled ash rock. Coniferous tree growth was not successful. Planting truncated trees or cuttings without heads makes rooting easier.

According to Hodgson and Buckley,[31] trees and shrubs planted on ash disposal sites cannot be used for forest production, but they can be used to protect the environment. The main factor limiting their introduction is toxic levels of boron. Cemented layers prevent normal growth of roots. Sixteen species of trees and shrubs have been planted on ash with a pH of 8.8, on medium-compact clayey soil (pH, 7.8), on fly ash covered with a 15-cm thick layer of clump, and on ash covered with a 10 to 15-cm thick layer of ash mixed with fertile soil. Two plant species did not grow at all, six species grew better on clump than on ash, and eight species grew on ash but not on clump. Survival rate and growth of such species as hawthorn (Crataegus), alder (Alnus glutinosa), spruce (Picea sitchensis), olive (Elaeagnus), and poplar (Populus) were better on ash covered with a layer of clump or soil. Good results have been obtained on a mixture of ash with clump because of the dilution of boron and pH change. It is recommended that pits be dressed with soil when planting trees, for better soil economy. The addition of a small amount of soil (1350 cm^3) in pits increased the average annual increment of a tree growth six times. In the experiment, the application of the greatest mass of soil gave the best results.

Other experiments conducted by Hodgson and Buckley[31] included planting trees and shrubs as follows:

- On a dry and very hard ash containing 100 ppm of available boron under a loose and broken layer of 10 cm.
- On wet ash containing 14 ppm of boron, planted with maple (Acer pseudoplatanus), birch (Betula pendula), field maple (Fraxinus excelsior), spruce (Picea sitchensis), poplar (populus robusta), and willow (Salix caprea) into 40-cm diameter pits filled with fertile soils or ash. Spacing was 1.1 x 1.1 m with one year dibbled seedlings. Some experimental plots were seeded with trefoil vaccinated with nitrogen fixing bacteria.

Results of these experiments prove that poplars and spruces react positively to pits dressed with fertile soil. The rate of poplar growth was decreased as a result of using up nitrogen. Nitrogen, applied in the amount of 35 g on 3-year old trees, decreased this trend. Addition of fertile soil facilitated the absorption of nitrogen by trees. After 5 years, trees were cut and weighed. Dressing pits with soil had the same effect as 2 years of cultivation with trefoil. Reaction of trees to trefoil was greater when pits were dressed with fertile soil. The first experiment, however, showed atrophy of leaders and offshoots in spring. Dressing pits with soil slightly improved tree growth, while trefoil hindered their growth, probably because of the small root system of the trees and competition for water. Roots did not penetrate hardened ash but were growing horizontally in the loose ash to a depth not greater than 7 cm from the surface.

Based on these experiments and on the observation of natural succession after recession of glaciers,[15] scientists claim that cultivating trees that fix nitrogen [alder (Alnus crispa) and arctic willow (Salix)] can provide the nitrogen for climax species. Alder (Alnus crispa) is able to fix up to 68 kg/ha of nitrogen per year. Similar properties have been noted for such species as black alder (Alnus glutinosa), locust tree (Robinia *pseudoacacia*), olive (*Elaeagnus angustifolia*). There is a danger that shallow roots may not provide stability during winds, however.

Vanicek[32] reports that 43 species (2576 individuals) of trees and plants were planted on ash and slag disposal sites in Czechoslovakia in the period 1954-57. After 4 to 7 years, only 16 species (1292 individuals) survived. The best growth was observed when peat and mineral fertilizers were added. Based on these experiments, the following species have been recommended for biological consolidation of disposal surfaces:

- *Ailonthus glandulosa* (tree of heaven)
- *Populus candensis* (Canadian poplar), *P. nigra* (black poplar), *P. Simonii* (Simona poplar), *P. alba* (white poplar), *P. charcoviensis* (Charkov poplar), *P. tremula* (aspen)
- *Tamarix gallica* (tamarisk)
- *Elaeagnus angustifolia* (olive)
- *Colutea arborescens* (no English name)
- *Evonymus europea* (European evonymus)
- *Alnus incana* (gray alder)
- *Salix alba* (white willow)
- *Betula alba* (white birch).

INVESTIGATION OF RECLAMATION OF ALKALINE ASH PILES

The objectives of the first stage of research conducted under this investigation[7] was to determine physico-chemical and biological properties of selected ash types and to perform experimental testing on the effectiveness of methods to reduce the toxicity of the ash waste to plant growth.

The first efforts involved testing the effectiveness of methods used for the following purposes:

- To change alkalinity (lower pH)
- To reduce negative effect of salinity
- To improve air-water properties
- To initiate soil formation processes by soil microbes.

The effectiveness of neutralizing sulphate-calcium ashes produced from burning lignite (Konin Power Plant) and silicate-aluminum ashes produced from burning bituminous coal (Halemba Power Plant) was tested in greenhouse pot experiments. Selected properties of the ashes were discussed earlier in the report. White mustard (Sinapis alba L.) was selected as a test plant.

Results of these experiments were used to assess individual methods of fertilization and neutralization. The individual treatments were ranked against a fertile soil control. Results were judged on the dry mass yield of the aboveground portion.

	Ash from Bituminous Coal	Ranking
1)	Control I = fertile soil + NPK Mg	- 1.00
2)	Ash + NPK Mg + m* + low moor peat 314 g/pot	- 0.98
3)	Ash + NPK Mg + m + 1 cm layer of silt	- 0.89
4)	Ash + NPK Mg + m at 80 percent max. water capacity	- 0.86
5)	Ash + NPK Mg + m + low moor peat 31.4 g/pot	- 0.82
6)	Ash + NPK Mg + m, strongly pressed (compacted)	- 0.81
7)	Ash + NPK Mg + m + 25 percent of mineral (light soil)	- 0.81
8)	Ash + NPK Mg + m + high moor peat 31.4 g/pot	- 0.80
9)	Ash + NPK Mg + m + green manure from legumes (80.5 g/pot)	- 0.79
10)	Ash + NPK Mg + m + high moor peat 314 g/pot	- 0.79
11)	Ash + NPK Mg + m + green manure from cereals (80.5 g/pot)	- 0.75
12)	Ash + 2 (NPK Mg)	- 0.74
13)	Ash + NPK Mg	- 0.73
14)	Ash + 2 (NPK Mg) + low moor peat 31.4 g/pot + flowers of sulphur 10 g/pot	- 0.72
15)	Ash + NPK Mg	- 0.70
16)	Ash + NPK Mg + m + sulphuric acid 1 n (125 cm^3/pot	- 0.69
17)	Ash + NPK Mg + m + gypsum 3.14 g/pot	- 0.67
18)	Ash + NPK Mg + m + high moor peat 31.4 g/pot = flowers of sulphur 10 g/pot	- 0.54
19)	Ash + NPK Mg + m + low moor peat 31.4 g/pot + flowers of sulphur 10 g/pot	- 0.48
20)	Ash + 2 (NPK Mg) + 2 m + low moor peat 31.4 g/pot	- 0.42
21)	Ash + low moor peat 31.4 g/pot	- 0.38
22)	Ash + NPK Mg + m + green manure from cerals 322 g/pot	- 0.34
23)	Ash + 25 percent of barren river sand	- 0.33
24)	Ash + high moor peat 31.4 g/pot	- 0.33
25)	Ash + NPK Mg + m + green manure from legumes 322 g/pot	- 0.14
26)	Control III = pure ash without fertilization	- 0.12
27)	Control II = washed barren river sand	- 0.07

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* m = microelement addition.

Ash from Lignite

		Ranking
1)	Control I = fertile soil + NPK Mg	1.00
2)	Ash + NPK Mg + m + low moor peat 31.4 g/pot	0.60
3)	Ash + NPK Mg + m	0.58
4)	Ash + NPK Mg + m + high moor peat 314 g/pot	0.53
5)	Ash + NPK Mg + m + 1 cm layer of silt	0.51
6)	Control III = pure ash without fertilization	0.44
7)	Ash + NPK Mg	0.44
8)	Ash + NPK Mg + m + high moor peat 31.4 g/pot	0.40
9)	Ash + NPK Mg + m + light soil - 25 percent capacity	0.40
10)	Ash + NPK Mg + m + green manure from cereals 31.4 g/pot	0.39
11)	Ash + NPK Mg + m + low moor peat 314 g/pot	0.31
12)	Ash + NPK Mg + m + sulphuric acid 1 n 125 cm³/pot	0.27
13)	Ash + 25 percent barren river sand	0.26
14)	Ash + low moor peat 31.4 g/pot	0.20
15)	Ash + high moor peat 31.4 g/pot	0.20
16)	Ash + NPK Mg + m + green manure from legumes 80.5 g/pot	0.19
17)	Ash + NPK Mg + m + gypsum 3.14 g/pot	0.14
18)	Ash + NPK Mg + m, strongly pressed	0.14
19)	Ash + NPK Mg + m at 80 percent max. water capacity	0.08
20)	Control II = washed barren river sand	0.07
21)	Ash + 2 (NPK Mg) + 2 m + low moor peat 31.4 g/pot	0.07
22)	Ash + NPK Mg + m + low moor peat 31.4 g/pot + flowers of sulphur 10 g/pot	0.03
23)	Ash + NPK Mg + m + high moor peat 31.4 g/pot + flowers of sulfur 10 g/pot	0.02
24)	Ash + 2 (NPK Mg) + 2 m + high moor peat 31.4 g/pot	0.02
25)	Ash + NPK Mg + m + green manure from cereals 322 g/pot	0.02
26)	Ash + 2 (NPK Mg)	0.02
27)	Ash + NPK Mg + m + green manure from legumes 322 g/pot	0.01

Results of the greenhouse experiments and the investigation of changes in the properties of the formed ash soils indicated that methods for improving alkaline soil conditions, such as the addition of sulphuric acid, flowers of sulfur, and gypsum, did not give the expected results. Decidedly toxic environments for mustard growth were observed on a number of neutralization combinations compared with the calcium-sulphate ashes produced from burning lignite. In seven cases, yields were lower than on barren sand (Control II). Pure ash (Control III) gave crops that amounted to only 12 percent (Halemba) or 44 percent (Konin) of the crops gathered from the cultivated sandy soil (Control I).

A description of the results of field experiments performed by Wysocki[7] during the period 1975-1981 is presented in other sections of this report.

SECTION 5

THE OBJECT AND METHODOLOGY OF RESEARCH

GENERAL SCOPE OF WORK

The objective of this research was to solve the following problems:

- Reclamation of the surface of ash disposal sites for agricultural use
- Reclamation of the surface of ash disposal sites for forest use.

The subject of the research is highly alkaline ash waste piles produced by burning bituminous coal and lignite in power plants and in thermal-electric power stations. Highly alkaline materials are those with a pH exceeding 8.5.

Two ash disposal sites in Poland were selected for this study:

1) A disposal site formed by hydraulic transport from the Halemba Power Plant (bituminous coal ash and slags)

2) A disposal site formed by hydraulic transport from the Konin Power Plant (lignite ash and slags).

In 1974, the author began research financed by the U.S. Environmental Protection Agency. In the period 1974-1977, the following work was accomplished:

- Laboratory determination of ash properties in relationship to their suitability for soil formation
- Greenhouse pot experiments in which various ash treatments were evaluated with respect to supporting plant growth
- Field experiments with herbaceous plants, trees, and shrubs to determine their growth and yields under various ash treatments. In addition, the soil formation process from ashes was investigated. Results of these experiments were published in a report.[7] Field

experiments were carried out through one (ash disposal for Konin) or two (ash disposal for Halemba) vegetation periods. This was considered to be too short a time to obtain reliable results, so the field experiments were continued through the 1978-1981 period. It was believed that 4 or 5 years of experiments would give results independent of climatic conditions.

The extended field experiments (1978-1981) produced the conclusions and recommendations that are the subject of this report.

METHODOLOGY OF RESEARCH

The problems connected with the reclamation of alkaline ash piles were studied in the following phases:

- Phase I - Review of tests and research efforts carried out by various scientists under various conditions, including investigations of the properties of wastes and the conditions under which they were disposed.
- Phase II - Greenhouse pot experiments to test the effect of agents that neutralize alkaline ashes or improve growth conditions for plants.
- Phase III - Selection of promising methods to neutralize or change ash properties to enhance the establishment and growth of vegetation; testing their effectiveness and growth; testing their effectiveness under field conditions and experimental conditions.
- Phase IV - Assessment of the effectiveness of various treatments by indirect means (observation of growth, yields, dynamics of changes in formed soil environment properties, and usability of crops); an assessment of trees and shrubs by observation of growth dynamics, health, and changes in soil formed.

Results obtained during the first two phases (1974-1975) were presented in a separate publication[7] and summarized in previous sections of this report. Field experiments in Phases III and IV (1975-1977) were also presented in the publication mentioned above.[7] In the period 1978-1981, the field experiments and laboratory tests were continued on selected experimental areas in Halemba and Konin. The detailed methodology of pedological, chemical, climatological tests, etc., are discussed in appropriate sections of the report.

The detailed description of field experiments presented herein will permit the adaptation of the results to other areas of the world.

Ash Disposal From the Halemba Power Plant

Figure 4 shows the location of the Halemba Power Plant in Poland. At this plant, the bottom ash and fly ash from electric precipitators are removed hydraulically and transported to a flat diked area about 1.5 km away. The first soil dikes were 4 to 6 m high. The disposal area covered about 10 ha, and about 2.3 million m^3 of waste bulk was disposed of in the period 1962-1973.

The mixture was discharged into one of the disposal sites. Overflow wells which drain clarified water from above the sediment were located at the opposite side of the inlet. The effluent water was directed to a water course in the vicinity, and recycled effluent was used several times in the process of hydraulic transport.

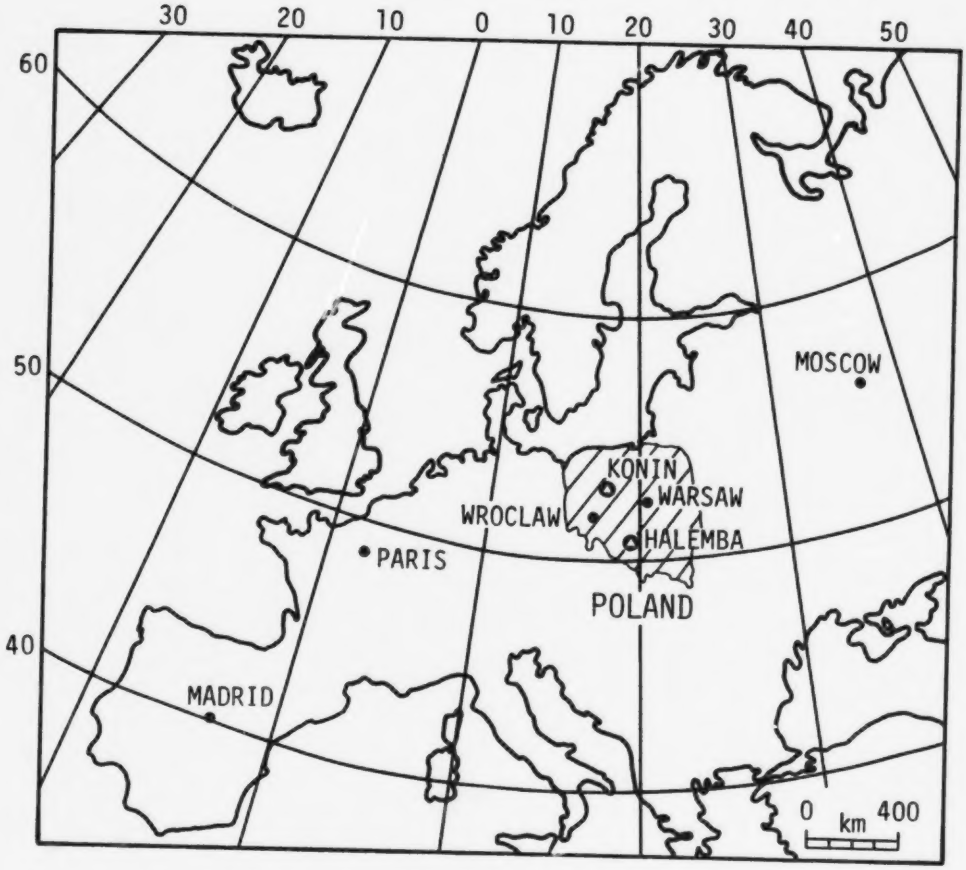
The disposal site at Halemba is situated at an elevation about 245 m above sea level, and it is located in a highly industrialized region. Air pollution fallout resulting from this location affected the results of the field experiments. On the ash disposal site selected for the field experiments, attempts were made to consolidate the top surface and slopes by using biological and other methods to protect them against fugitive dust.

Ash Disposal From the Konin Power Plant

Figure 4 shows the location of the Konin Powerplant. This power plant is fired with lignite containing 21 to 25 percent ash (dry mass). The lignite deposits are found among deposits of Miocene.

After highly sulphurized lignite is blended with lignite containing small amounts of sulphur, the pulverized coal is burned without any further additives. Bottom ash and fly ash from the electrofilters are hydraulically removed to sedimentation ponds similar to those at Halemba; however, the ponds are 4 to 6 m deep. (Dikes are not elevated because of unfavorable geotechnical conditions of the ash.)

The disposal site is situated at an elevation 90 m above sea level, and it covers an area of about 13 ha. The field site is near both the powerplant and an aluminum plant that generates a considerable amount of air pollution. In the area adjacent to the experimental plots, attempts were made to consolidate the top layer by using biological cover.


30
20
10
0
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30
40
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60
50
40
MOSCOW
KONIN
WARSAW
WROCLAW
HALEMBA
PARIS
POLAND
MADRID
0
km
400

Δ Location of power plants and field experiments.

Figure 4. Sites of field experiments.

SECTION 6

FIELD EXPERIMENTS

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CLIMATIC CONDITIONS

Halemba

Precipitation measurements were made about 0.5 km from the experimental field. Other climatic data were obtained from a climatological station located 10 km from the site. Climatological data for the period 1974-1981 are presented in Figure 5.

The higher-than-average air temperatures in the winter of 1974/1975 were caused by southwesterly winds carrying warm and humid air. May was a particularly warm month, which positively affected vegetation conditions for herbaceous plants. Trees and shrubs planted in this period required frequent watering. In the fall (October 1974), temperatures rapidly dropped below the average and heavy rains occurred. Low temperatures were observed throughout the entire winter and spring of 1976. The summer of 1976 was average. In October 1976, the temperature dropped rapidly (to -30°C), and then average winter conditions prevailed again. In the later spring of 1977, temperatures rose rapidly (up to +17.7°C on March 23 and 25 and to +27.2°C on April 30) and then unexpectedly dropped (average +0.7°C on June 1), which caused freezing of young tree sprouts (particularly locust trees and alders). Subsequent rises in temperature and favorable rains positively influenced the hay crops in June 1977. The following months were cool. A cold spring in 1978 dalayed the vegetation period by about 20 days. In the summer (June-August) temperatures were generally lower than average (+16.6°C in June and August and +17.2°C in July). Temperatures lower than 10°C were observed for 24 days in May, 16 days in June, 12 days in July, and 11 days in August. On May 11 and 12, frosts (-1.5°C) damaged developing sprouts of trees and shrubs. A cool spring in 1979 delayed the vegetation period by about 15 days; however, snow cover disappeared quite early. This delay caused the first cutting of grasses to be gathered at the beginning of June, rather than in the middle of May. The summer of 1979, which was quite warm and moderately humid, affected the second crop of legumes; however, rainfalls were unsatisfactory for grasses growing on ashes at such high air temperatures. The spring of

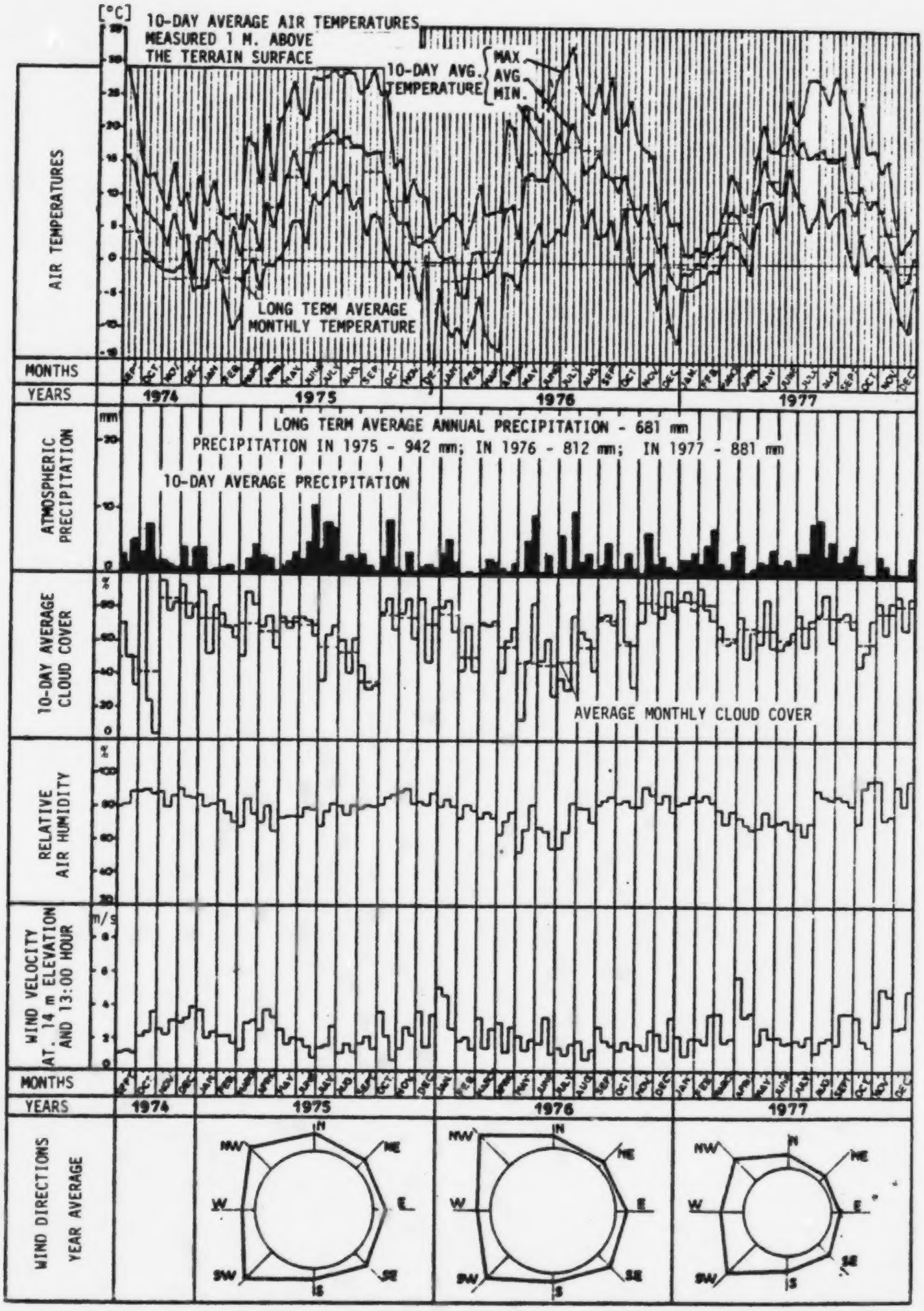


Figure 5. Climatic conditions at the Halemba field plots, 1974-81.

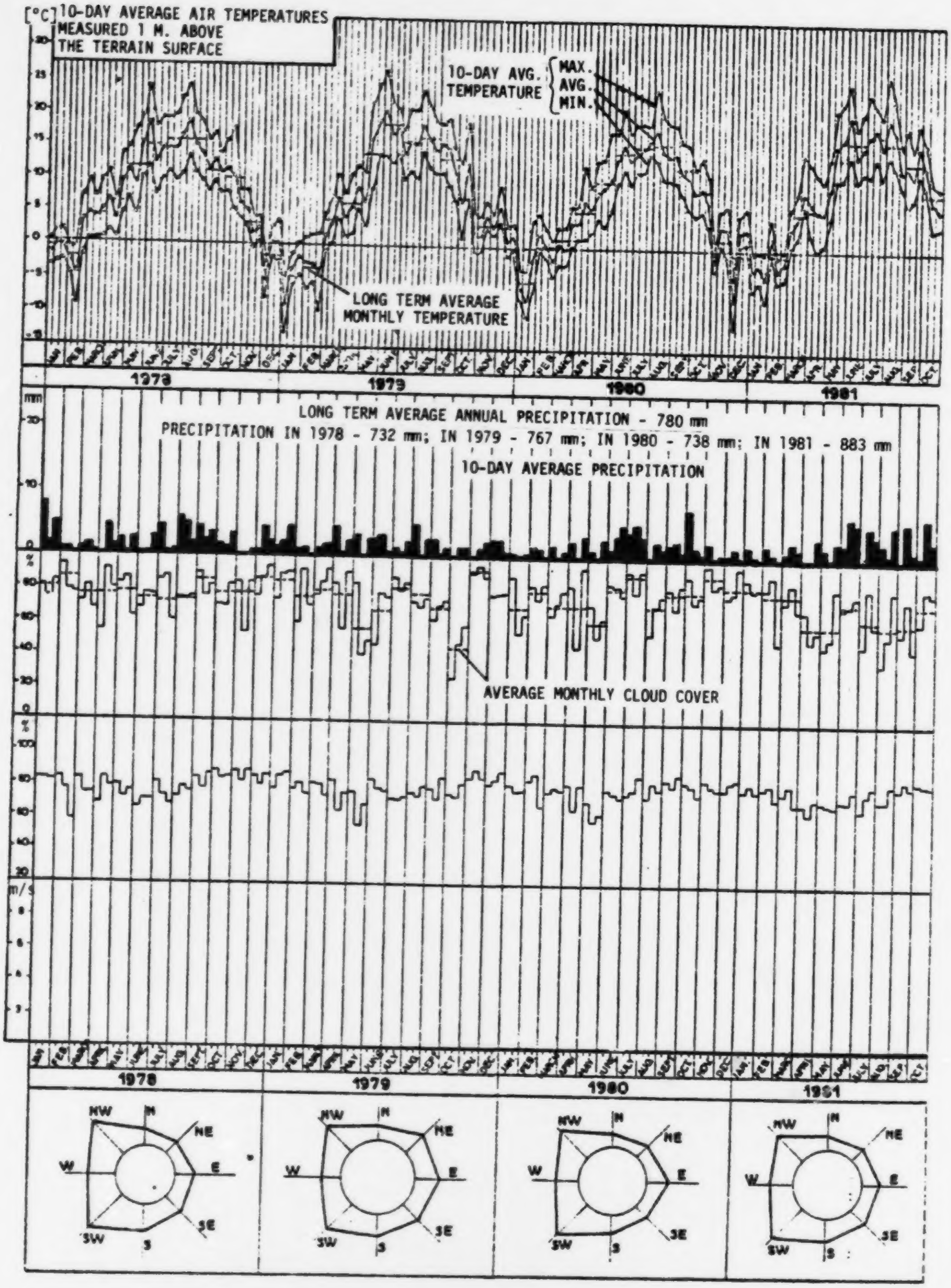


Figure 5 (continued). Climatic conditions at the Halemba field plots (1974-81).

1980 was again delayed by about 2 or 3 weeks. Summer temperatures were lower than average. Barley was sown in the fall during dry and relatively warm periods, which positively affected the plants. The summer of 1981 can be considered average.

The average annual precipitation for the Halemba region is 681 mm. The year 1975 was exceptionally wet, as precipitation was 942 mm (a large share of which represented heavy rains and snows in winter and storms in June and July). May was a particularly unfavorable month for plants because of unsatisfactory precipitation connected with high temperatures, low humidity, and strong drying winds. In 1976, precipitation was significantly lower (81.2 mm), and the distribution was more favorable. In May, which is a decisive month for agriculture, precipitation was twice as high as average. Periodical heavy rains in the spring of 1977 produced good yields of the first grass crop. The following months were very wet and cool, the yield of the second hay crop was relatively good. Light precipitation (snowfall) in the winter of 1977/1978 did not provide a reserve of soil moisture for the spring and summer. Poor precipitation in the spring also had a negative influence on the first crop. Torrential rains (67.6 mm during 3 days beginning on August 7, together with a successive rain wave beginning on August 17 (48.4 mm during 3 days) improved the state of the soil moisture. Low air temperatures of this period negatively influenced yields in the second grass crop, however. Considerable precipitation events in the fall did not affect vegetation and plant yields. The summer of 1979, which was moderately wet and warm, produced a relatively good second crop of legumes, but the rainfall was not satisfactory for grasses. In 1980, precipitation was about average (737.8 mm). Spring precipitation was average (30 to 65 mm/month), with higher precipitation occurring in June (110.1 mm) and July (126.0 mm). The year 1981 was a wet one (883.2 mm), although the spring was dry. The exceptionally high precipitation in June (159 mm) had no effect on barley, but was very favorable for tree and shrub growth.

Konin

Atmospheric conditions were observed at a climatological station 1 km removed from the waste disposal site. Results of these observations are presented in Figure 6.

Meteorological conditions in Konin were less favorable for field experiments than those at Halemba. Temperatures in the winter of 1974/75 were higher than average. January was particularly warm (average +4°C compared with an average of -2.8°C over many years. Temperatures in the spring and summer months were also higher than the average. High temperatures and low precipitation (434.5 mm in 1975 compared with a long-term average of 517 mm, and from February until June, only 89.6 mm compared with a normal 187.3 mm) caused excessive drying out of the soil, which

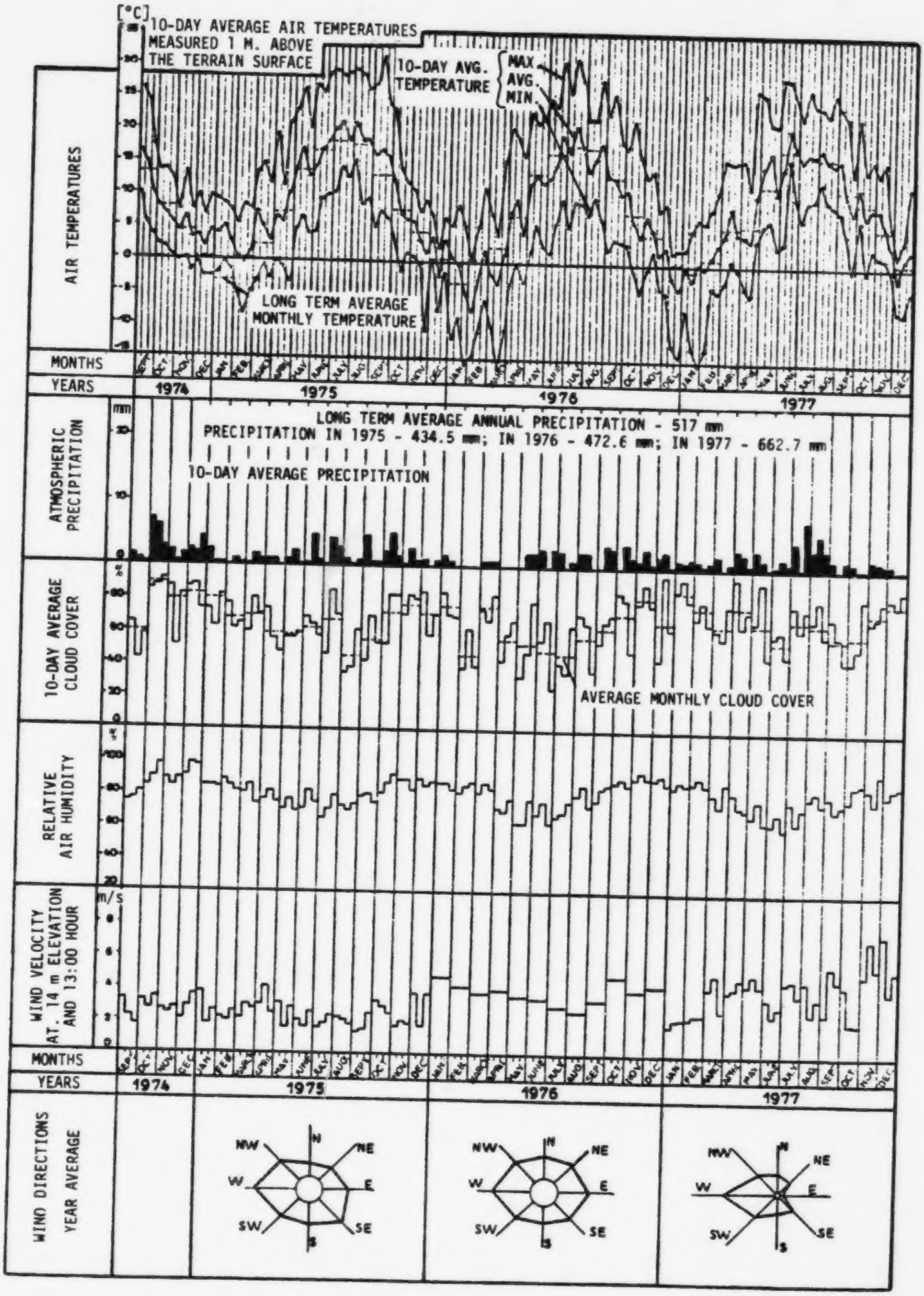


Figure 6. Climatic conditions at the Konin field plots, 1974-81.

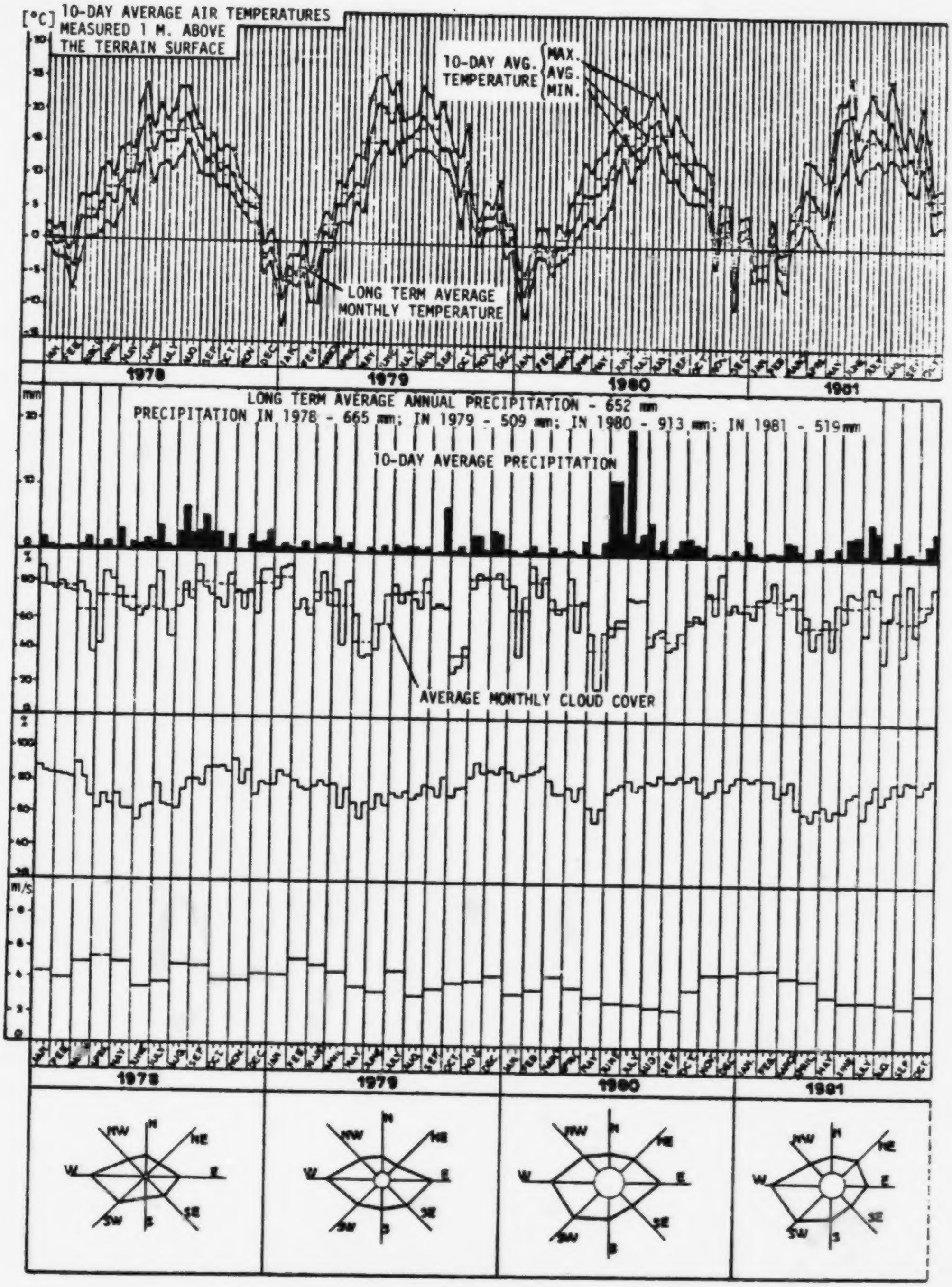


Figure 6 (continued). Climatic conditions at the Konin field plots, 1974-81.

greatly affected germination and growth of plants. As a result of these conditions, attempts to introduce herbaceous plants and trees failed almost completely in the spring of 1975.

Weather conditions improved in the fall of 1975. The winter of 1975/76 was long, lasting until the end of March 1976. Temperatures in the succeeding months of 1976 were average. It was also an exceptionally dry year. In the period from February until the middle of June, precipitation amounted to only 76.0 mm. Higher precipitation rates were not observed until late autumn.

More favorable precipitation in the winter of 1976/77 and in the vegetation season of 1977 resulted in good growth and yields of plants cultivated on the experimental plots.

The year 1978 was wet (665 mm); however, most rains occurred in the fall (August-October). Temperatures were unfavorable, particularly in the spring and in the middle of summer. Frosts occurred in April (-2.2°C) and low temperatures in May (0.1°C on May 11). This condition was unfavorable for the yield of the first hay swath, but rather favorable for the growth of trees and shrubs.

Spring arrived late in 1979 as a result of exceptionally high snowfall in later winter. Snow melted until the middle of April, i.e., until the time when cereals normally begin to spread. High soil moisture in the ashes resulted in good yields of grasses and legumes in the first cutting. Relatively high temperatures, unsatisfactory rainfall, and frequent strong winds created unfavorable conditions for the growth of herbaceous plants; therefore, the second hay crop was not gathered in August 1979.

Spring was also late in 1980. Relatively large and late snowfalls (March, April) caused floods of rivers in the vicinity of the site, which affected air humidity and caused low temperatures. These events caused exceptionally good yields of herbaceous plants and intensive growth of trees and shrubs. Summer was very wet; e.g., a single precipitation event measured 60 mm. Land set aside for winter barley was cultivated during the rainy period. In general, this year was exceptionally favorable for growth of legumes and grassy plants and favorable for growth of trees and shrubs.

In 1981, winter barley was cultivated under close to average meteorological conditions. Typical rainfalls in spring and summer contributed to the poor spreading of cereals and to low yields.

AIR POLLUTION

Air pollution in the experimental area was characterized by continuous measurement of the dust fallout (Figure 7), 20-minute concentrations of SO_2 (Figure 8), and 20-minute concentrations of F_2 (Figure 9).

Dust fallout was measured by using a sediment vessel. The exposure time was from one measurement until the next one. Instantaneous concentrations of SO_2 were determined by an aspiration method, which is based on the absorption of gas in 5 percent solution of potassium chlorate. Fluorine was determined by bonding its volatile compounds with a solution of sodium hydroxide and determining F_2 content by titration with a solution of thorium nitrate in the presence of an alizarin indicator at a pH of 2.9.

Measurements taken in the areas where vegetation experiments took place indicate that air pollution was significant (frequently exceeding applicable standards) and probably had a negative effect on biochemical processes.

PREPARATION OF EXPERIMENTS FOR AGRICULTURAL RECLAMATION

The field tests involved the use of a series of independent tests (with one variable) on 30 cultivated blocks 6 x 18 m, each with 4 repetitions of the treatment of plots 4 x 5 = 20 m^2 (Figures 10 and 11).

The cultivated area was divided into 10 ash treatments designed to change the soil properties of ash, and four plant combinations, depending on the kind of pioneer plants.

Ash Treatments

The 10 ash treatments were as follows:

A. Covering with 20-cm layer of fertile soil (2000 m^3/ha) + NPK
B. Covering with 10-cm layer of fertile soil (1000 m^3/ha) + NPK
C. Covering with 5-cm layer of fertile soil (500 m^3/ha) + NPK
D. Covering with 5-cm layer of tertiary acidic sand (500 m^3/ha) + NPK at Konin or with bentonite (100 m^3/ha) + NPK at Halemba

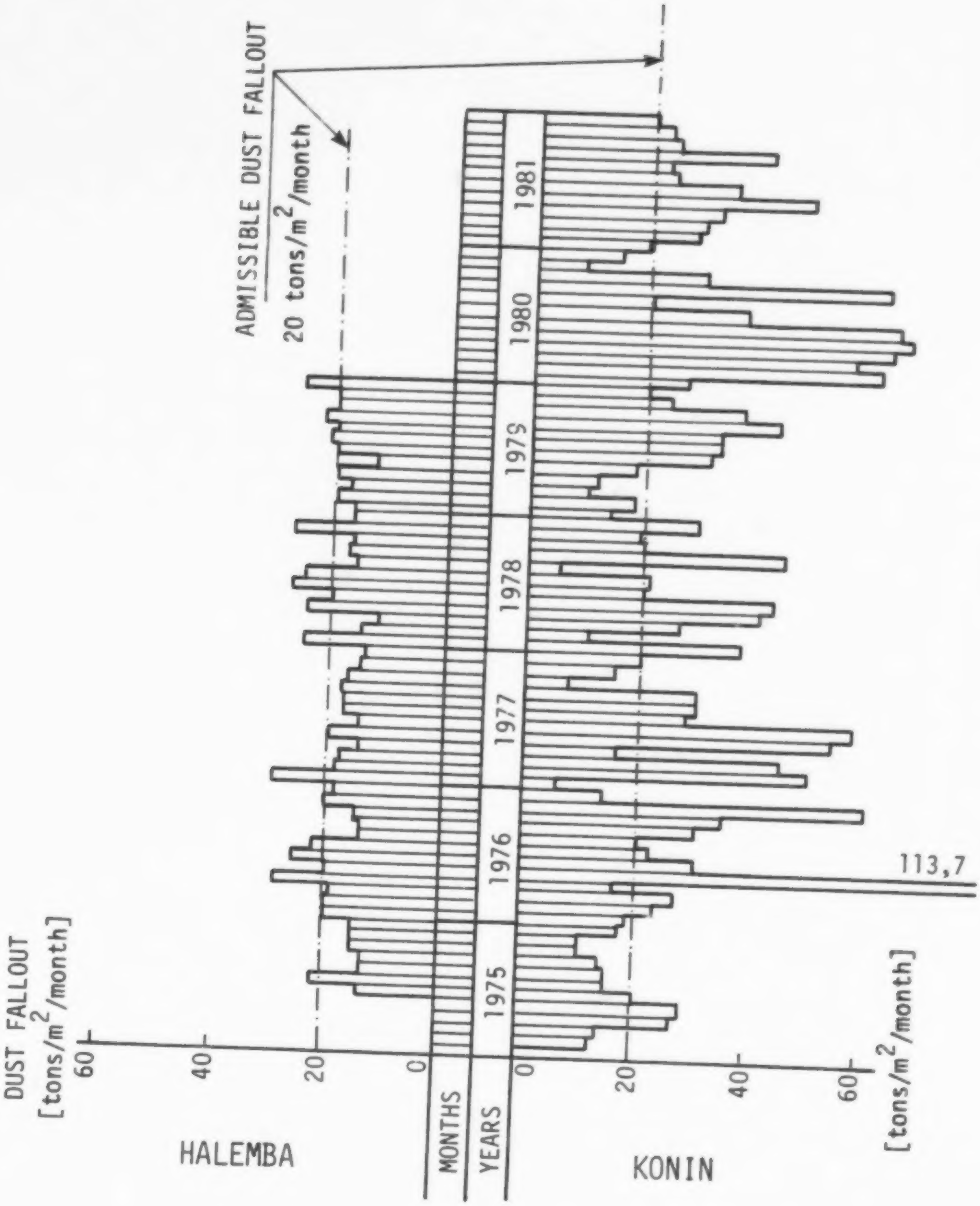


Figure 7. Dust fallout on experimental plots in Halemba and Konin.

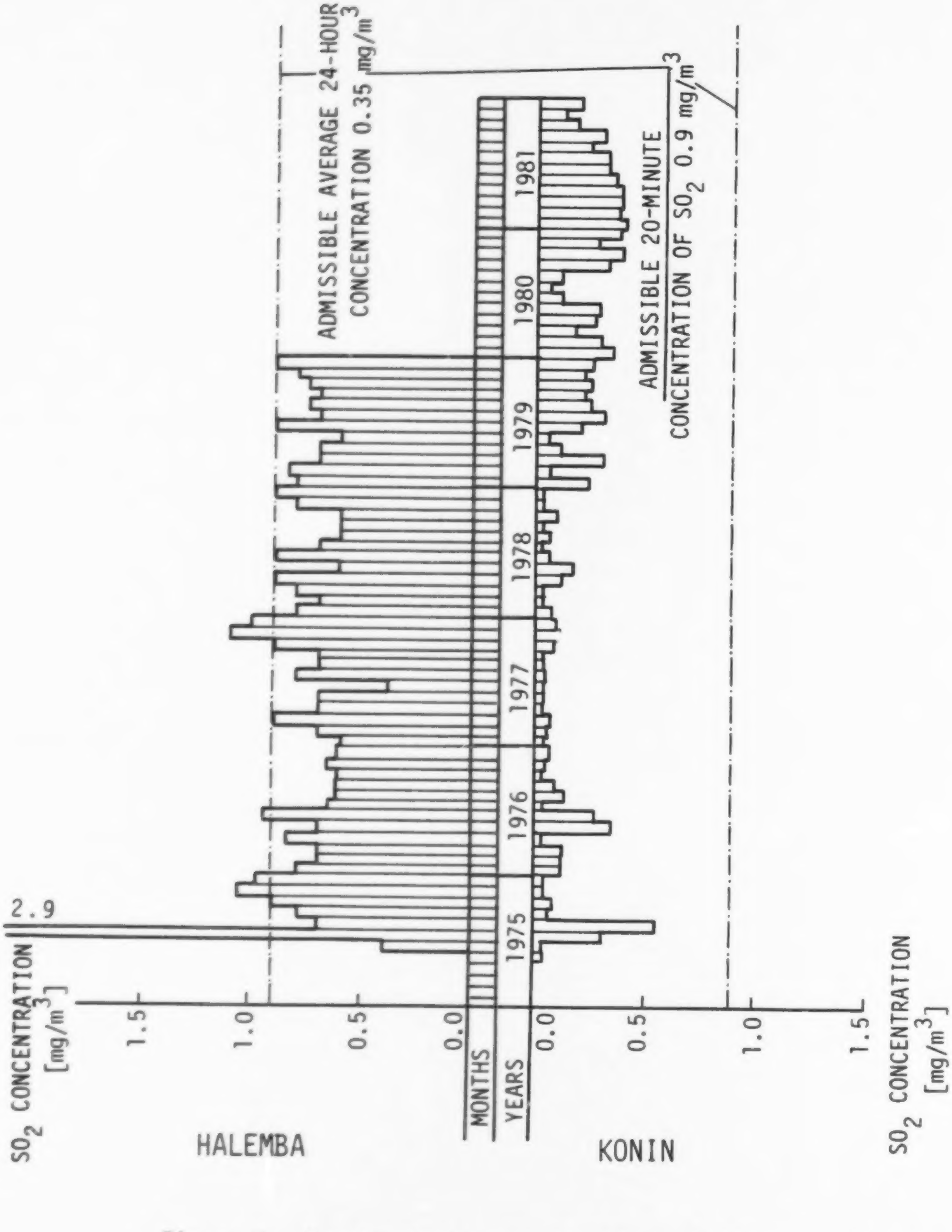


Figure 8. Twenty-minute concentrations of SO_2 measured over experimental plots in Halemba and Konin.

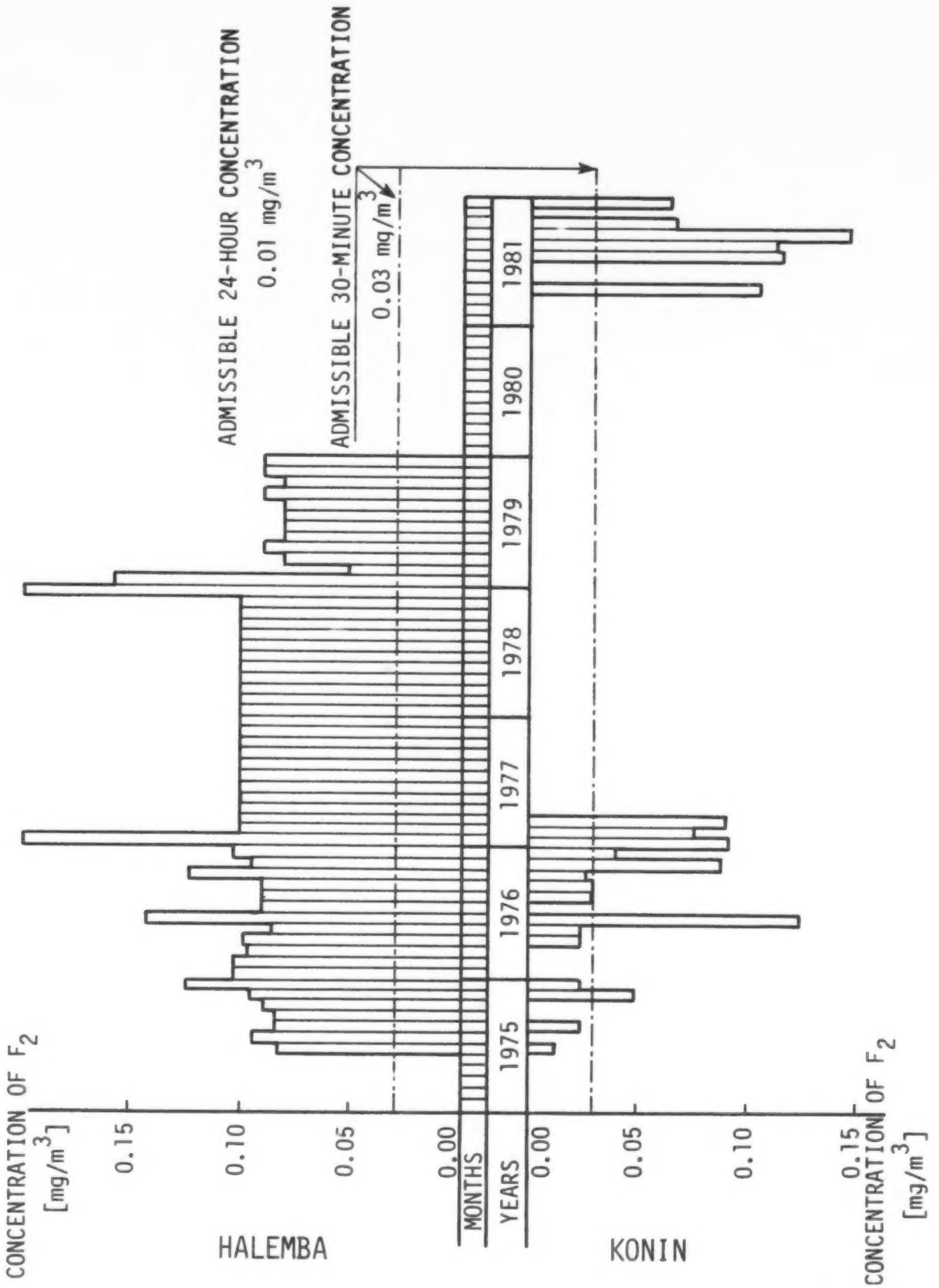
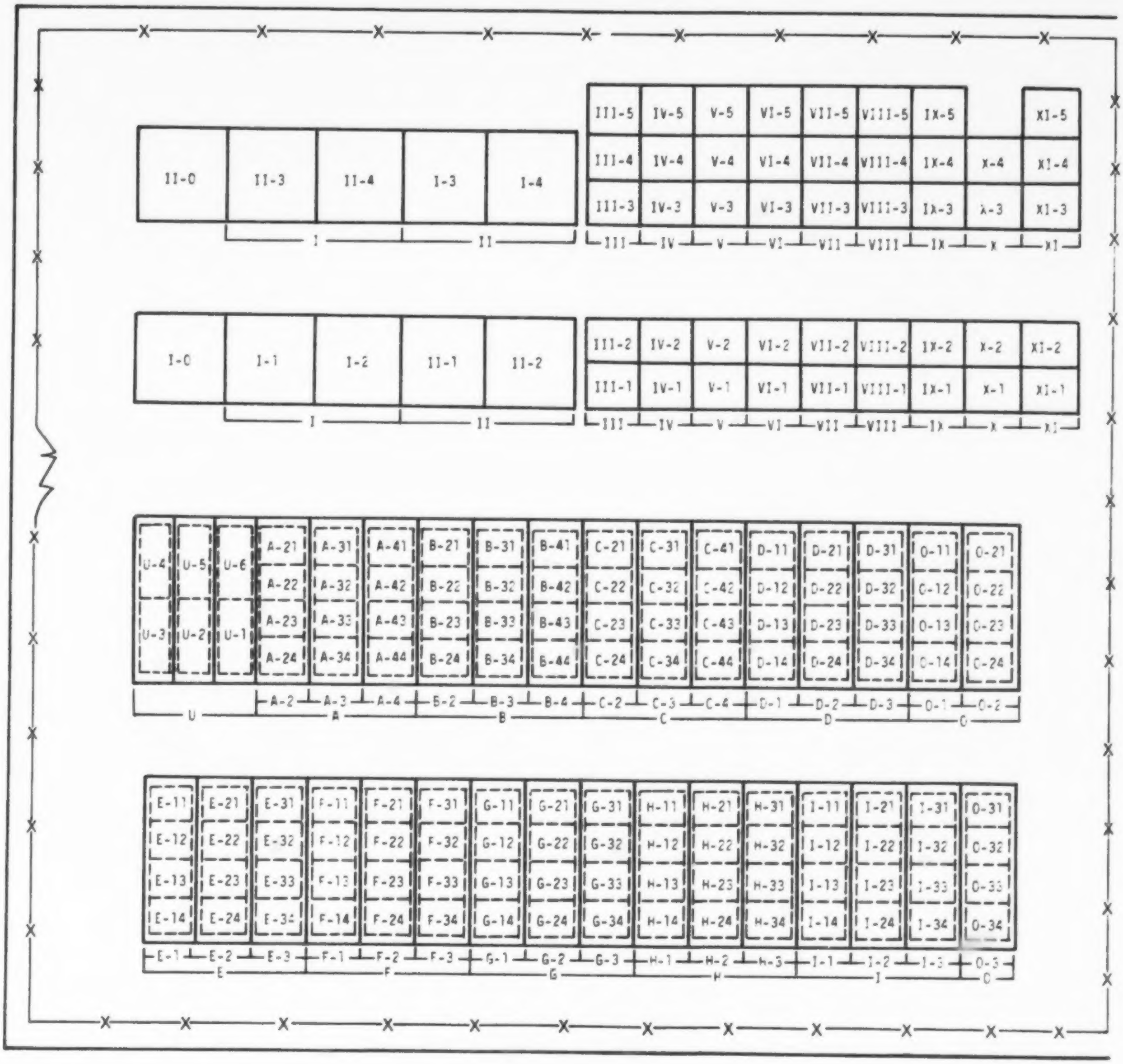


Figure 9. Twenty-minute concentrations of F_2 measured over experimental plots in Halemba and Konin.


III-5 IV-5 V-5 VI-5 VII-5 VIII-5 IX-5 XI-5
II-0 II-3 II-4 I-3 I-4
III-4 IV-4 V-4 VI-4 VII-4 VIII-4 IX-4 X-4 XI-4
III-3 IV-3 V-3 VI-3 VII-3 VIII-3 IX-3 X-3 XI-3
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III IV V VI VII VIII IX X XI
III-2 IV-2 V-2 VI-2 VII-2 VIII-2 IX-2 X-2 XI-2
I-0 I-1 I-2 II-1 II-2
III-1 IV-1 V-1 VI-1 VII-1 VIII-1 IX-1 X-1 XI-1
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U-4 U-5 U-6 A-21 A-31 A-41 B-21 B-31 B-41 C-21 C-31 C-41 D-11 D-21 D-31 O-11 O-21
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U-3 U-2 U-1 A-23 A-33 A-43 B-23 B-33 B-43 C-23 C-33 C-43 D-13 D-23 D-33 O-13 O-23
A-24 A-34 A-44 B-24 B-34 B-44 C-24 C-34 C-44 D-14 D-24 D-34 O-14 O-24
A-2 A-3 A-4 B-2 B-3 B-4 C-2 C-3 C-4 D-1 D-2 D-3 O-1 O-2
U A B C D O
E-11 E-21 E-31 F-11 F-21 F-31 G-11 G-21 G-31 H-11 H-21 H-31 I-11 I-21 I-31 O-31
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E-13 E-23 E-33 F-13 F-23 F-33 G-13 G-23 G-33 H-13 H-23 H-33 I-13 I-23 I-33 O-33
E-14 E-24 E-34 F-14 F-24 F-34 G-14 G-24 G-34 H-14 H-24 H-34 I-14 I-24 I-34 O-34
E-1 E-2 E-3 F-1 F-2 F-3 G-1 G-2 G-3 H-1 H-2 H-3 I-1 I-2 I-3 O-3
E F G H I O

Figure 10. Plan of field plots - Halemba.

Agricultural Reclamation

1. Ash treatment combinations

A. Covering with fertile soil (20 cm) + NPK
B. Covering with fertile soil (10 cm) + NPK
C. Covering with fertile soil (5 cm) + NPK
D. Covering with bentonite (100 m^3/ha) + NPK
E. Addition of 10 Mg/ha of low peat + NPK
F. Addition of 10 Mg/ha of mountainous peat + NPK
G. Addition of 20 Mg/ha of farm manure (in calculation of dry mass) + NPK
H. Addition of N2PK
I. Addition of NPK
O. Inspection without fertilization (control)

2. Mixtures of seeds

1. Lucerne

a)	Lucerne	50 kg/ha
b)	White melilot	10 kg/ha
	Total	60 kg/ha

2. Grass mixture

a)	Meadow fescue	12 kg/ha
b)	Orchard grass	4 kg/ha
c)	Smooth bromegrass	12 kg/ha
d)	Kentucky bluegrass	5 kg/ha
e)	Creeping fescue	17 kg/ha
f)	White clover	3 kg/ha
g)	Black medic	7 kg/ha
h)	White melilot	5 kg/ha
i)	Darnel	13 kg/ha
j)	Redtop	4 kg/ha

3. Mixture of legumes

a)	Lucerne	36 kg/ha
b)	Orchard grass	6 kg/ha
	or dernel	24 kh/ha
	Total	42 or 60 kg/ha

4. White melilot

a)	White melilot	50 kg/ha

Forest Reclamation

1. Species of trees and bushes

I. Poplar I in pits 0.7 x 0.7 x 0.7 m - spacing 3 x 3 m
II. Poplar II 0.7 x 0.7 x 0.7 m - spacing 3 x 3 m
III. Birch in pits 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m
IV. Black alder 0.5 x 0.5 x 0.5 m - spacing 1 x m
V. Grey alder 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m
VI. Locust tree 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m
VII. Larch 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m
VIII. Pea shrub 0.3 x 0.3 x 0.3 m - spacing 1 x 1 m
IX. Willow in pits 0.3 x 0.3 x 0.3 m - spacing 1 x 1 m
X. Willow cuttings - spacing 0.5 = 1 m
XI. Poplar cuttings - spacing 0.5 = 1 m

2. Cultivation combinations

1. Treatment of pits with fertile soil:

For 1 m^3:	fly ash	0.75^3
	fertile soil	0.25 m^3
	ammonium nitrate	0.13 kg
	superphosphate	0.30 kg
	potash soil	0.13 kg

2. Treatment of pits with ash and bentonite clay:

For 1 m^3:	ash	0.90 m^3
	bentonite	0.13 m^3
	ammonium nitrate	0.13 kg
	superphosphate	0.30 kg
	potash soil	0.13 kg

3. Treating of pits wtih peat:

For 1 m^3:	ash	- 1.00 m^3
	mountain peat	- 8 kg (16 Mg/ha)
	mineral fertilizers as in pos. 1	

4. Filling up of ditches with mixture + NPK:

For 1 m^3:	ash	- 1.00 m^3
	mineral fertilizers as in pos. 1	

Figure 10a. Key to Figure 10 - Halemba.

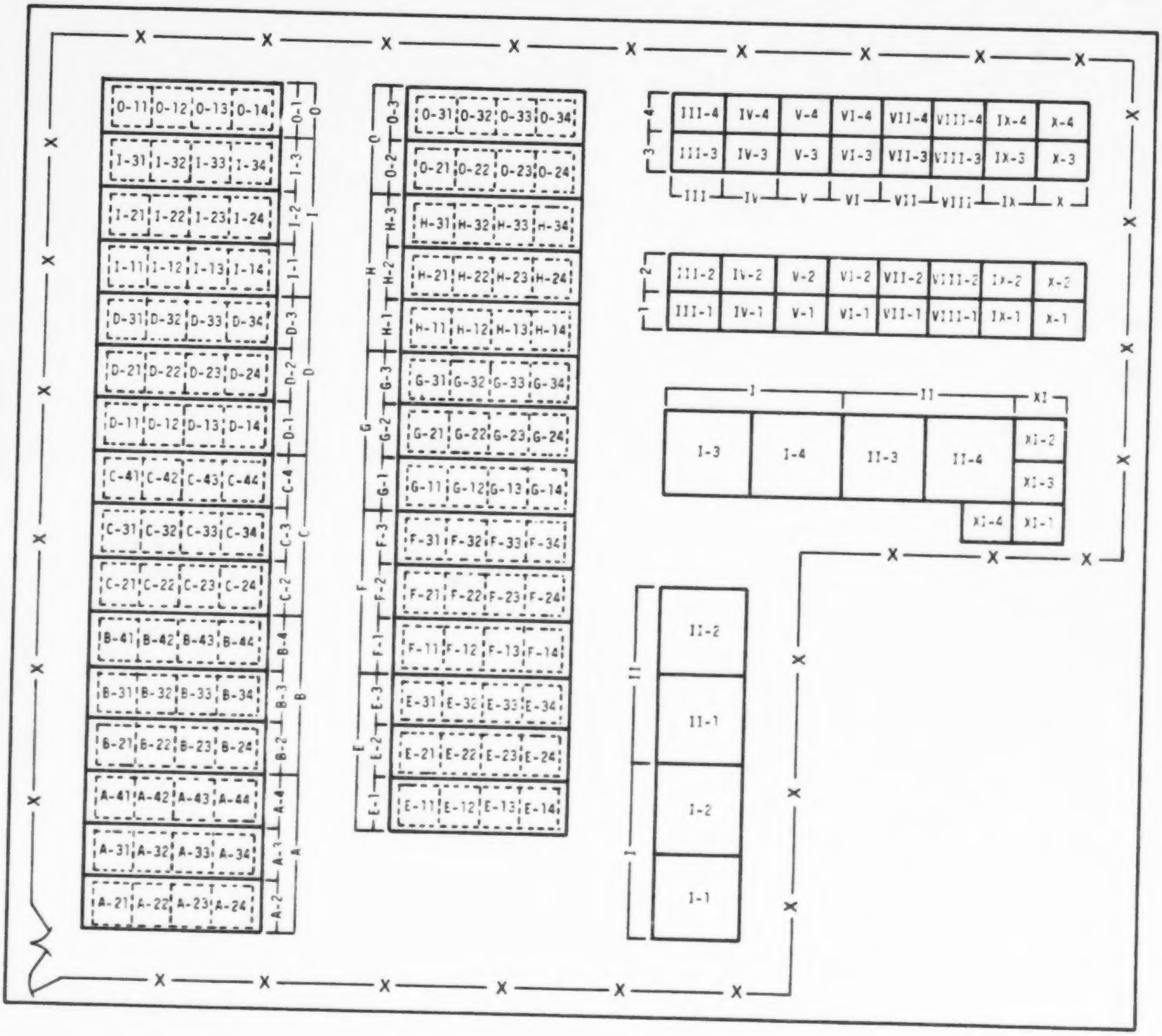

Figure 11. Plan of field plots - Konin.

Agricultural Reclamation

1. Combinations

A. Covering with fertile soil (20 cm) + PK
B. Covering with fertile soil (10 cm) + PK
C. Covering with fertile soil (5 cm) + PK
D. Covering with tertiary sand 500 m²/ha + PK
E. Addition of 10 Mg/ha of low peat + PK
F. Addition of 10 Mg/ha of mountainous peat + PK
G. Addition of 20 Mg/ha of farm manure (in calculation of dry mass) + PK
H. Addition of 40 Mg/ha of green fertilizer (maize) + PK
I. Addition of PK
O. Inspection without fertilization (control)

2. Mixtures of seeds (1976)

1. Sainfoin:

a) Sainfoin in a pure state	280 kg/ha

2. Grass mixture:

a) Meadow fescue	24 kg/ha
b) Orchard grass	8 kg/ha
c) Smooth bromegrass	24 kg/ha
d) Kentucky bluegrass	10 kg/ha
e) Creeping fescue	34 kg/ha
f) White clover	6 kg/ha
g) Black medic	14 kg/ha
h) White melilot	6 kg/ha
i) Darnel	26 kg/ha
j) Redtop	8 kg/ha

3. Mixture of legumes:

a) Lucerne	72 kg/ha
b) Orchard grass	12 kg/ha
Total	84 kg/ha

4. White melilot

a) White melilot in a pure state	100 kg/ha

Forest Reclamation

1. Species of trees and bushes

I. Poplar I in pits 0.7 x 0.7 x 0.7 m - spacing 3 x 3 m
II. Poplar II 0.7 x 0.7 x 0.7 m - spacing 3 x 3 m
III. Birch in pits 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m
IV. Grey alder 0.5 x 0.5 x 0.5 m - spacing 1 x m
V. Black alder 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m
VI. Locust tree 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m
VII. Willow 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m

VIII. Sea buckthorn in pits 0.3 x 0.3 x 0.3 m - spacing 1 x 1 m
IX. Pea shrub in pits 0.3 x 0.3 x 0.3 m - spacing 1 x 1 m
X. Poplar cuttings - spacing 0.5 = 1 m
XI. Larch in pits - spacing 0.5 x 0.5 x 0.5 m - spacing 1 x 1 m

2. Cultivation combinations

1. Treatment of pits with fertile soil + ash + PK:

For 1 m³:

ash	0.75 m³
fertile soil	0.25 m³
ammonium phosphate	0.30 kg
urea	0.13 kg

2. Treatment of pits with ash + tertiary sand + PK:

ash	0.75 m³
tertiary sand	0.25 m³
mineral fertilizers as in pos. 1	

3. Treating of pits with low peat + PK:

For 1 m³:

ash	1.00 m³
low peat (dry moss)	16 kg
mineral fertilizers as in pos. 1	

4. Filling up of ditches with mixture + PK:

For 1 m³:

ash	1.00 m³
mineral fertilizers as in pos. 1	

5. Treatment of pits with fertile soil + PK:

For 1 m³:

fertile soil	1.00 m³
ammonium phosphate	0.30 kg
urea	0.13 kg
potash soil	0.12 kg

Figure 11a. Key to Figure 11 - Konin.

E. Addition of low moor peat (10 t/ha dry mass), i.e., 30 m^3/ha of air-dried peat + NPK
F. Addition of gardening high moor peat (10 t/ha dry mass) + NPK
G. Fertilization with farm manure (20 t/ha) + NPK
H. Mineral fertilization with double dose of phosphoric fertilizers; N2PK
J. Use of standard mineral fertilizers (NPK)
O. Control (without fertilizers)

Because of the lack of vegetation on the H series plots at Konin in the fall of 1975, the H series plot treatment was modified with the additional treatment of chopped maize at a rate of 40 t/ha mixed in with a deep plow. Plots of this series were then redesignated by the letter K.

The fertile soils used on plots A, B, and C were a humus soil from meadow areas formed from shallow peats at Halemba and a humus soil of agricultural soils formed from clayey sands of glacial original at Konin.

Bentonite (used at Halemba) is a waste material obtained from the bituminous coal mines. Its main component is montmorillonite, which has a high sorption capacity and large amounts of clayey fraction that should improve the air/water and sorptive properties of formed ash soils.

Tertiary sand (used at Konin) was obtained from the overburden removed from the lignite mine in Konin. The sand contains acidified coal substances and a sandy fraction that improves the textured character of ashes and acidifies them.

The fertilizer described in Table 7 was used prior to mixing the ash with neutralizing agents, before sowing and as a top dressing.

Crop Blocks

As shown in Figures 10 and 11, four crops were used:

1. On treatment combinations D, E, F, G, H, J, and O, the following plants were used at Konin:

° Sainfoin (*Onobrychis viciaefolia*)	- 140 kg/ha
° Crown vetch (*Coronilla varia*)	- 70 kg/ha
Total	210 kg/ha

On the same combinations, the following were used at Halemba:

° Alfalfa (*Medicago sativa*)	- 50 kg/ha
° White melilot (Melilotus albus)	- 10 kg/ha
Total	60 kg/ha

TABLE 7. SCHEDULE OF MINERAL FERTILIZATION OF THE EXPERIMENTAL PLOTS IN THE SPRING OF 1975

Timing and placement of fertilization	Type of commercial fertilizer	Dose of fertilizer component, kg/ha			
		Halemba		Konin	
		NPK	N2PK	NPK	N2PK
Prior to mixing ash with neutralizing agents	Treble superphosphate, 46 percent P_2O_5	140	210	140	210
	Ammonium nitrate, 34 percent N	35	35	-	-
Before sowing	Treble superphosphate, 46 percent P_2O_5	70	140	140	140
	Ammonium nitrate, 34 percent N	50	50	50	50
	Potash salt, 60 percent K_2O	30	30	30	30
Top dressing	Ammonium nitrate, 34 percent N	35	35	35	35

2. On all grass/legume combinations:

° Meadow fescue (*Festuca pratensis*)	- 12 kg/ha
° Orchard grass (*Dactylis glomerata*)	- 4 kg/ha
° Awnless bromegrass (*Bromus inermis*)	- 12 kg/ha
° Kentucky bluegrass (*Poa pratensis*)	- 5 kg/ha
° Creeping fescue (*Festuca rubra*)	- 17 kg/ha
° Tall oat-grass (*Arrhenatherum elatius*)	- 13 kg/ha
° Redtop (*Agrostis stolomifera*)	- 4 kg/ha
° White clover (*Trifolium repens*)	- 3 kg/ha
° Black medic (*Medicago lupulina*)	- 7 kg/ha
° White melilot (*Melilotus albus*)	- 5 kg/ha
Total	82 kg/ha

3. On all alfalfa with orchard grass concentrations:

° Alfalfa (*Medicago sativa*)	- 36 kg/ha
° Orchard grass (*Dactylis glomerata*)	- 6 kg/ha
Total	42 kg/ha

4. On treatment combinations A, B, and C, the following was cultivated:

° White melilot (*Melilotus albus*) alone at 50 kg/ha

Seed Bed Preparation

The neutralizing amendments and initial portions of mineral fertilizers were spread on designed plots and rototilled to a depth of 20 cm. After 6 to 10 days, mineral fertilizers were applied and the plots were harrowed. A few days later seeds were sown, and the plots were again harrowed and rolled with a smooth roller.

EXPERIMENTS IN AGRICULTURAL-TYPE RECLAMATION, 1975-1980

Halemba

Good germination and growth of plants were observed on experimental plots established in the spring of 1975. The intensity of the germination and growth of grasses and legumes depended on the treatment given to a plot.

In August 1975, all plots (except the control series "O") were fertilized with ammonium nitrate at a dose of 50 kg/ha, i.e., 20 kg/ha of pure nitrogen. On September 29, 1975, plants were mowed for the first time on all plots and samples were taken for laboratory analyses.

In the winter of 1976/76, some plants (particularly alfalfa) were frozen because of very low temperatures and a lack of snow cover. Under normal conditions, the plants would have to be removed and reseeded; however, they were not so that the experimental conditions could be maintained. In the spring of 1976 all plots were sown with mineral fertilizers (60 kg/ha of P_2O_5, i.e., 400 kg/ha of commercial fertilizers in the form of superphosphate 18 percent, and 50 kg/ha of N, i.e., 110 kg/ha of urea 47 percent) and harrowed. The plants were harvested on June 10, 1976. Immediately thereafter, mineral fertilizers were sown: 50 kg/ha of P_2O_5 in the form of treble granulated superphosphate (46 percent) and 50 kg/ha in the form of urea (46 percent).

The harvesting, mineral fertilization, and long-lasting drought devastated the weak plants. Therefore, all plots were reseeded with a mixture of alfalfa (70 kg/ha) and orchard grass (12 kg/ha). The seeds were sown on June 21 and plots were harrowed. Germination of plants was slow because of a drought. Rains that occurred on July 6 and 21 improved plant growth; however, the growth was still poor and affected yields of the second cut. The plants were mowed on August 30, and the plots were subsequently fertilized with nitrogen at a rate of 50 kg/ha in the form of urea (46 percent) and 110 kg/ha of commercial fertilizer. Some plants continued to grow until winter, which permitted a third harvest.

In response to a request of the Project Officer during the 1977 growing season, mineral fertilization was applied to only two repetitions of each series (e.g., repetitions A-21 and A-31 in series A-2). The other two repetitions were not fertilized and did not receive cultivating treatments (repetitions A-23 and A-24 in series A-2). These repetitions were to evaluate the impact on plant growth with no maintenance.

In the spring of 1977, fertilizers were applied only to the treated plots at the following rates:

60 kg/ha of P_2O_5, (130 kg/ha of treble superphosphate) and
100 kg/ha of N (220 kg/ha of 46 percent urea).

The plots were harrowed after fertilization. The first cutting was collected on May 30, 1977, and the plots were refertilized at the same rate used in the spring. The second harvest was gathered on September 8, 1977.

In the spring of 1978, plots were fertilized at a rate 60 kg/ha of P_2O_5 and 100 kg/ha of N and then harrowed. The first harvest of hay was collected on June 8, 1978, and on June 13, the plots were again fertilized with mineral fertilizers at the same rate. The second harvest of hay was gathered on August 22, 1978. In 1978, numerous rodents (mice, etc.) appeared, and their presence was observed until the end of the field experiments.

On March 22, 1979, the plots were refertilized with multicomponent mineral fertilizers at the rate of 1000 kg/ha. The fertilizers contained the following components (per hectare):

- 13.5% N, i.e., 135 kg/ha in the form of urea
- 60.0% P_2O_5, i.e., 60 kg/ha in the form of superphosphate
- 20.0% K_2O, i.e., 200 kg/ha
- 6.0% MgO, i.e., 60 kg/ha
- Microelements (B, Zn, Mn, Cu, Mo, Co).

The plots were harrowed. On June 12, 1979, the first hay harvest was gathered; and on June 22, 1979, plots were fertilized with multicomponent fertilizer at the rate of 1000 kg/ha (as described above). On August 29 the second harvest of hay was gathered.

On March 27, 1980, multicomponent mineral fertilizer was sown at the rate of 1000 kg/ha. The plots were harrowed, and molehills and arvicole nests were destroyed. The first harvest of hay was collected on June 3, 1980, and on June 5, 1980, the multicomponent mineral fertilizer was applied again at the same rate. The second hay cutting was gathered on August 12, 1980, to allow for cultivation before winter cereals were sown.

Through the period 1975-1980, samples of soil and hay were regularly collected for laboratory analyses. Before the first and second harvests, photographs of the plots (Figures 12, 13, and 14) were taken and the collected crops were weighed. Dry samples of plants served as the base for assessing dry mass yields (hay) from individual plots.

Konin

The experimental treatment plots at Konin showed relatively good growth in the spring of 1975 on plots of A, B, and C series only (plots treated with fertile soil), except for plots where white melilot (*Melilotus albus*) was seeded. None of the crown vetch (*Coronilla varia*) germinated. The best germination occurred with orchard grass (*Dactylis glomerata*) and alfalfa (*Melicago sativa*). Poor germination can be ascribed mainly to adverse weather conditions (shortage of precipitation and high temperatures), adverse water-air properties of the "soil," salinization of the soil, and toxicity of boron content in the soil.

To counteract the poor growth of grasses and legumes at Konin, all plots except those of the control "0" series were fertilized with mineral fertilizers on August 28, 1975, at the

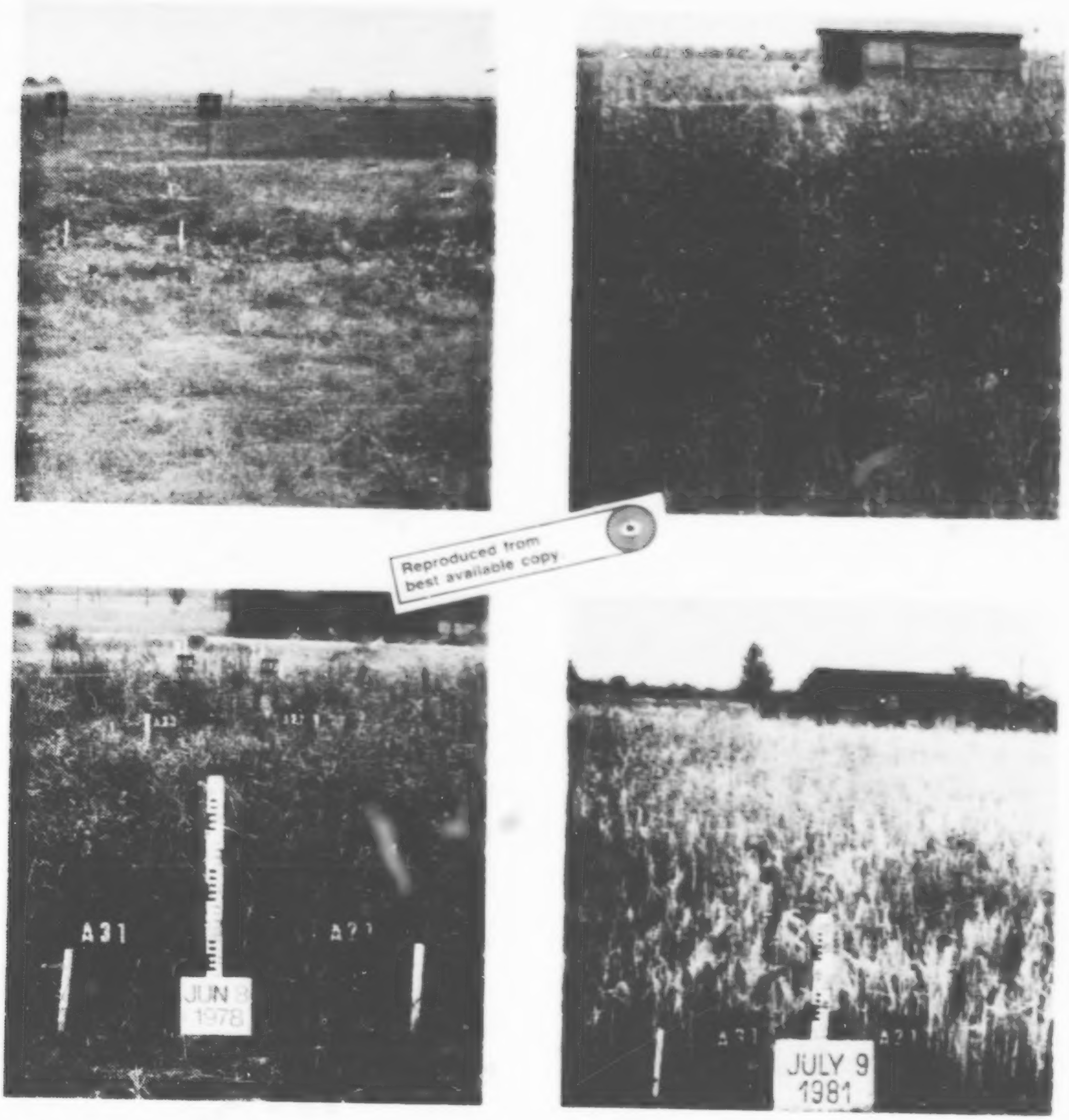
A31
A21
JUN 8
1978
A31
A21
JULY 9
1981

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Figure 12. Field experiment in Halemba. Ash covered with 20-cm layer of fertile soil + NPK. Crop rotation:
1975-1980: A-21 = mixture of grasses with legumes
A-31 = mixture of orchard grass with alfalfa
1981: Winter barley.

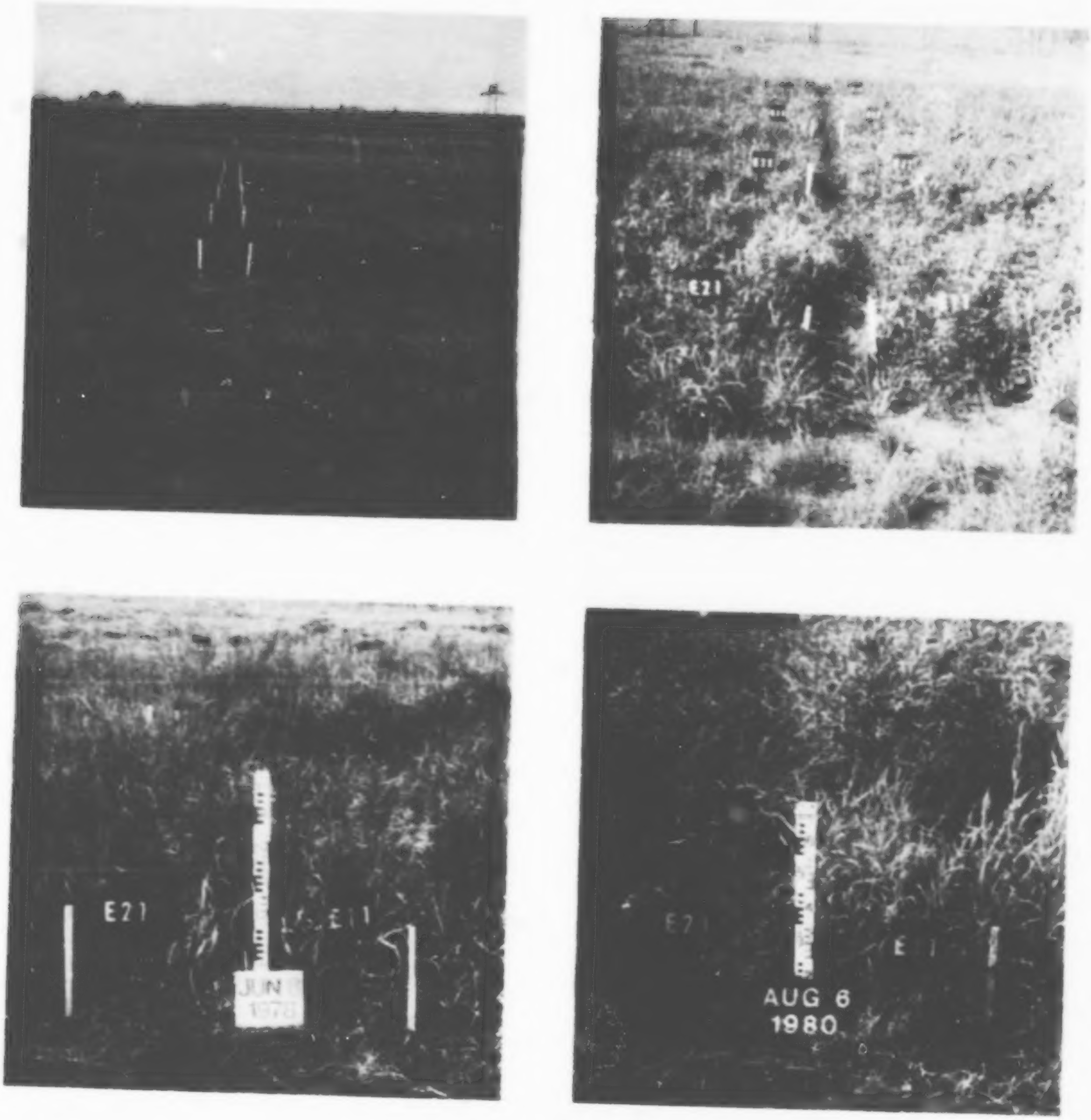
E21
E21
E11
JUN
1978
E21
E11
AUG 6
1980

Figure 13. Field experiment in Halemba. Ash with addition of low moor peat + NPK. Crop rotation in years 1975-1980:
E-11 mixture of alfalfa with melilot
E-21 mixture of grasses with legumes

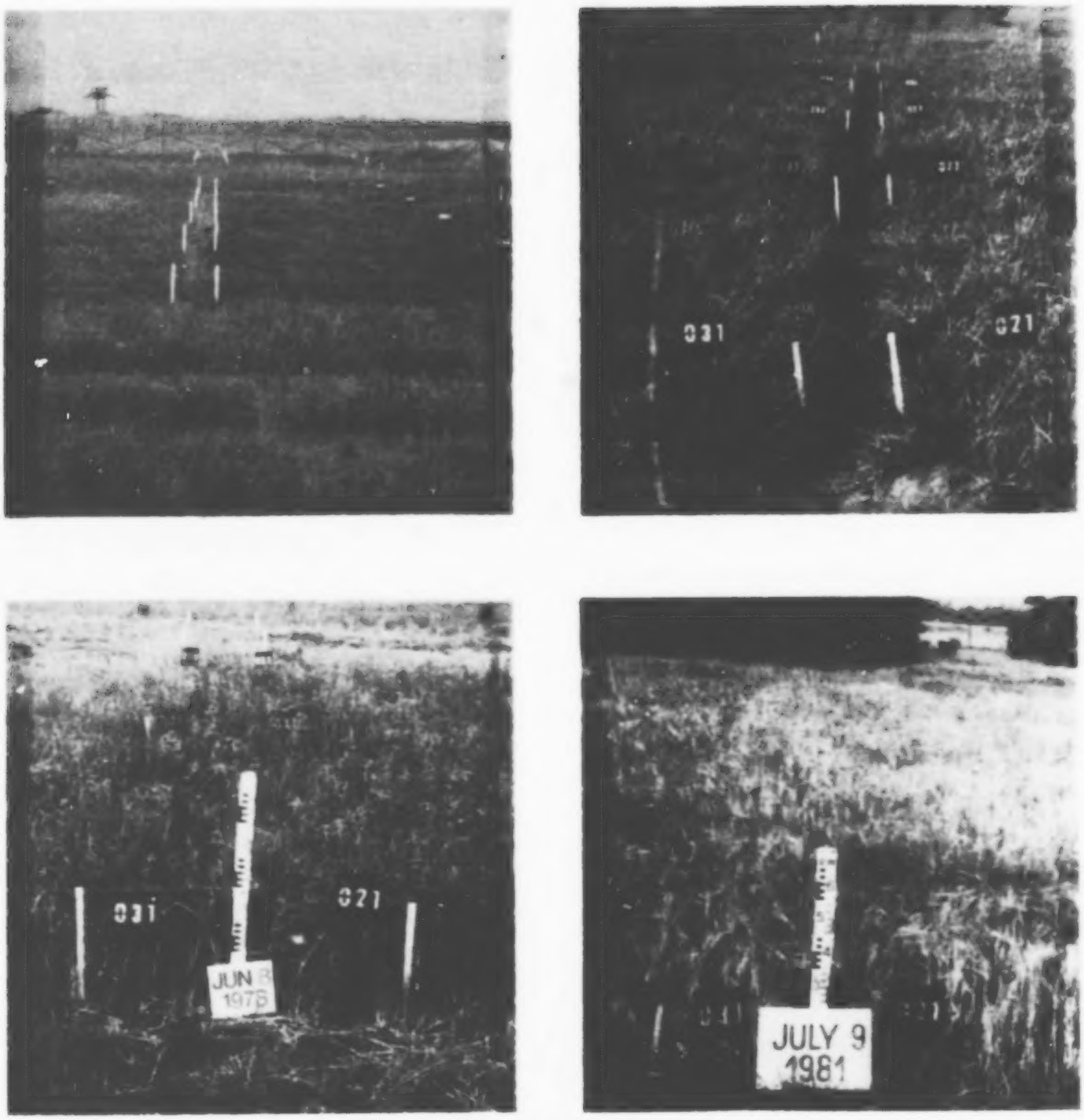
031
021
031
021
JUN 8
1976
JULY 9
1981

Figure 14. Field experiment in Halemba. Ash with mineral fertilizers NPK in years 1976-1981. Crop rotation:
1975-1980: 0-21 = mixture of grasses with legumes
0-31 = mixture of orchard grass with alfalfa
-1981: Winter barley.

following rates: 24 kg/ha N[50 kg/ha of 46 percent (N) urea], 90 kg/ha of P_2O_5, and 35 kg/ha N in the form of ammonium phosphate (18 percent N and 46 percent P_2O_5 at 200 kg/ha).

Despite sufficient precipitation during the second half of 1975, little improvement in vegetative growth occurred; therefore, the vegetation was not cut in 1975. In the autumn of 1975, numerous colonies of cyanoses (Chroococcales) appeared on the test plots. These colonies usually grow (in Poland) on wet limestones or on masonry.

Because vegetation attempts had not been successful, the experiment was modified. On three treatment combinations in the H series (H-1, H-2, and H-3), all vegetation had vanished in four repetitions. These plots were treated in the autumn of 1975 with 40 t/ha of green manure (cut maize). These plots were also fertilized at the following rates: 500 kg/ha of ammonium phosphate with 18 percent of N and 46 percent of P_2O_5, and 200 kg/ha of urea with 46 percent of N. The maize and fertilizer were tilled, and the plots were left in straight furrows for the winter.

In the spring of 1976, all plots were cultivated, fertilized, and reseeded. The following additional treatments were applied:

- Fertilization

  60 kg/ha of P_2O_5 (in the form of triple-granulated superphosphate) was applied prior to the vegetation period to all plots except the control "0" series.

  50 kg of N (in the form of urea) was applied to all plots after germination except those of the "0" series.

- Cultivation:

  All plots were harrowed after snow had melted and the surfaces had dried out, after fertilizers were applied, and after reseeding.

- Supplementary seeding consisted of

Mix 1 on plots D, E, F, G, H (K), J, O:	Seeding rate
- Sainfoin (*Onobrychis viciaefolia*)	- 280 kg/ha

Mix 2 on plots A-O - a mixure of grasses with legumes:

- Meadow fescue (Festuca pratensis)	-	24 kg/ha
- Orchard grass (Dactylis glomerata)	-	8 kg/ha
- Smoth bromegrass (Bromus inermis)	-	24 kg/ha
- June meadow grass (Poa pratensis)	-	10 kg/ha
- Red fescue (Festuca rubra)	-	34 kg/ha
- Tall rye-grass (Arrhenatherum elatius)	-	26 kg/ha
- Bentgrass (Agrostis stolonifera)	-	8 kg/ha
- White clover (Trifolium repens)	-	6 kg/ha
- Alfalfa (Medicago lupulina)	-	14 kg/ha
- White melilot (Melilotus albus)	-	6 kg/ha
Total		160 kg/ha

Mix 3 on plots A-O a mixture of lucerne with orchard grass:

- Lucerne (Medicago sativa)	72 kg/ha
- Orchard grass (Dactylis glomerata)	12 kg/ha
Total	84 kg/ha

Mix 4 on plots A, B, C:

- White melilot (Melilotos albus) seeding rate	100 kg/ha

All seeds of legumes were treated with nitrogen-fixing bacteria.

At Konin, the spring of 1976 was characterized by very low precipitation and prolonged cold weather, which delayed seed germination until June. On June 17, 1976, the first harvest was gathered from the plots on which were growing plants seeded in 1975. On the following day, plots of the series A-H (K) were fertilized at the following rates:

- 100 kg/ha of N in the form of 46 percent urea
- 50 kg/ha of P_2O_5 in the form of 18 percent granulated superphosphate

On September 23, 1976, the vegetation was harvested a second time. The highest yield of the harvest was obtained from the series covered with the 20-cm layer of fertile soil.

As at Halemba, at the request of the sponsor, fertilization of the treatment plots was eliminated in 1977 for one-half of the repetitions, and only crops were gathered. Therefore, in the spring of 1977, mineral fertilizers and harrowing was conducted only on repetitions 1 and 2. The rates of fertilizer applications were:

- 60 kg/ha of P_2O_5 in the form of 18 percent superphosphate
- 100 kg/ha of N in the form of 46 percent urea

Meteorological conditions were favorable in the spring of 1977 and the first harvest of hay was gathered on June 7. The yield from many plots compared favorably with crops from surrounding fields or meadows that are intensively farmed.

Immediately after the harvesting, the plots were fertilized [only repetitions 1 and 2 of series A-H (K) and (J)] at the same rates as in the spring. On September 8, the second hay harvest was gathered; the difference in yields from fertilized and nonfertilized plots was increasing.

In 1978, the course of the field work was similar to that of the previous year. On March 3, 1978, mineral fertilizers were applied and the plots were harrowed. On June 5, the first harvest of hay was gathered; on June 7, the second dose was collected. The application rates were the same as in the summer of the previous year. Legumes growing on fertilized plots began to disappear and the differences between yields obtained from fertilized and from nonfertilized plots were increasing, as at Halemba.

In 1979, the rates of mineral fertilization were modified. On repetitions 1 and 2, 1000 kg/ha of multicomponent fertilizer with the following composition was applied:

- 135 kg/ha of N in the form of urea
- 60 kg/ha of P_2O_5 in the form of superphosphate
- 200 kg/ha of K_2O
- 60 kg/ha of Mgo
- microelements: B, Zn, Mn, Cu, Mo, Co

The plots were fertilized and harrowed on March 27 and June 18. The crops were cut on June 15. Because of the unsatisfactory growth of plants, a second harvest of hay was not gathered that year. The poor yields were due to adverse properties of ash soil, high temperature of the air, and lack of rain.

In 1980, the first and second harvests of hay were gathered earlier to create more favorable conditions for sowing winter cereals. Mineral fertilizers were applied on March 31 and June 7--at the same rates as in 1979--and then harrowed. Crops were gathered on June 6 and August 14.

In the period from 1975 to 1980, samples of soil and plants were regularly collected for laboratory analysis. Results of these analyses are presented herein. Prior to harvesting, photographs of experimental plots were taken (Figures 15 through 17).

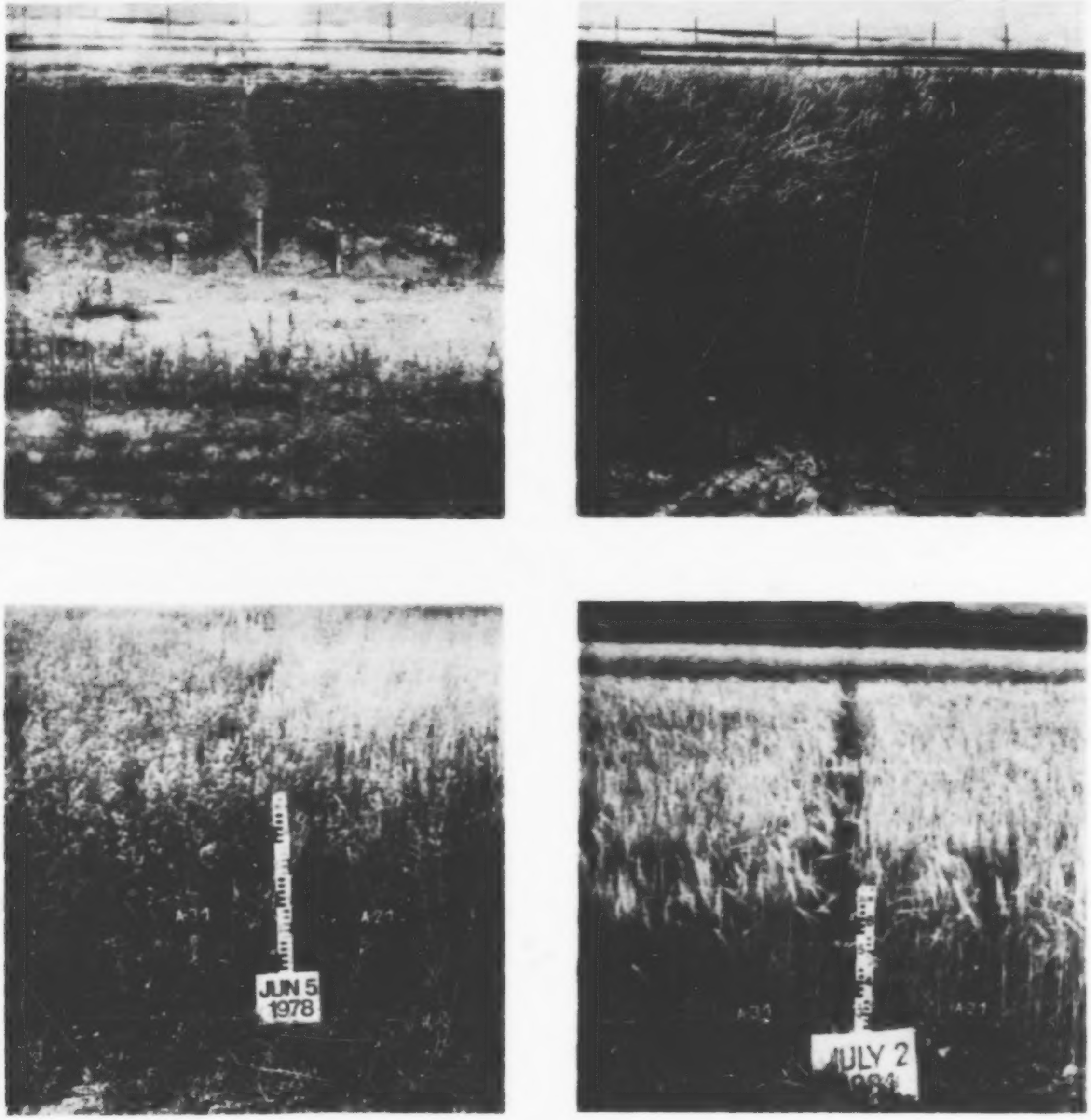
A-31
A-21
JUN 5
1978
A-31
A-21
JULY 2

Figure 15. Field experiment in Konin. Ash covered with 20-cm layer of fertile soil + NPK. Crop rotation:
1975-1980: A-21 (22, 24) = mixture of grasses with legumes
A-31 (32, 34) = mixture of orchard grass with alfalfa
-1981: Winter barley.

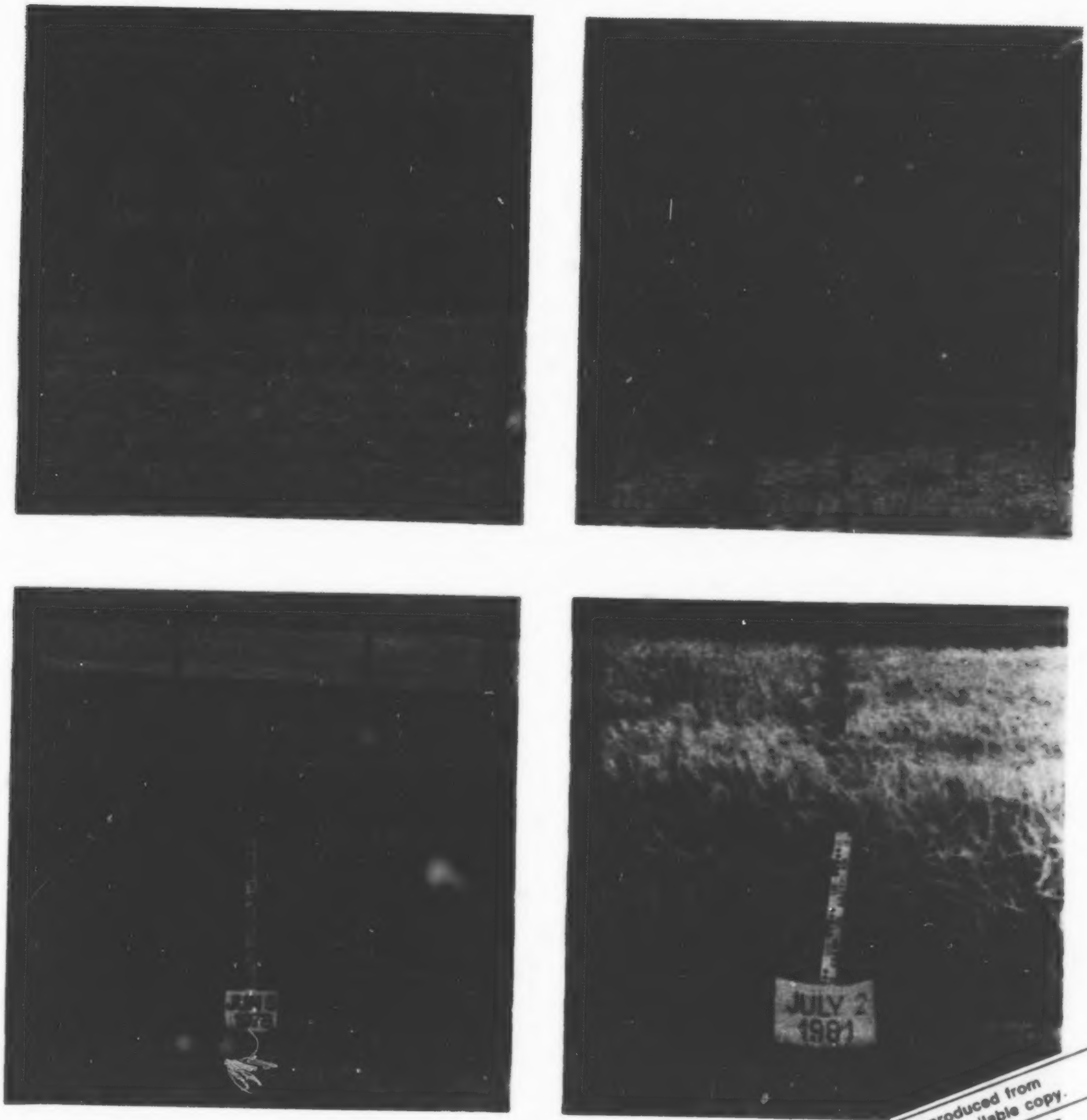

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Figure 16. Field experiment in Konin. Ash with addition of farm manure + NPK. Crop rotation:
1975-1980: G-11 (14) = mixture of holy clover
with crown vetch
G-21 (24) = mixture of grasses with legumes
-1981: Winter barley.

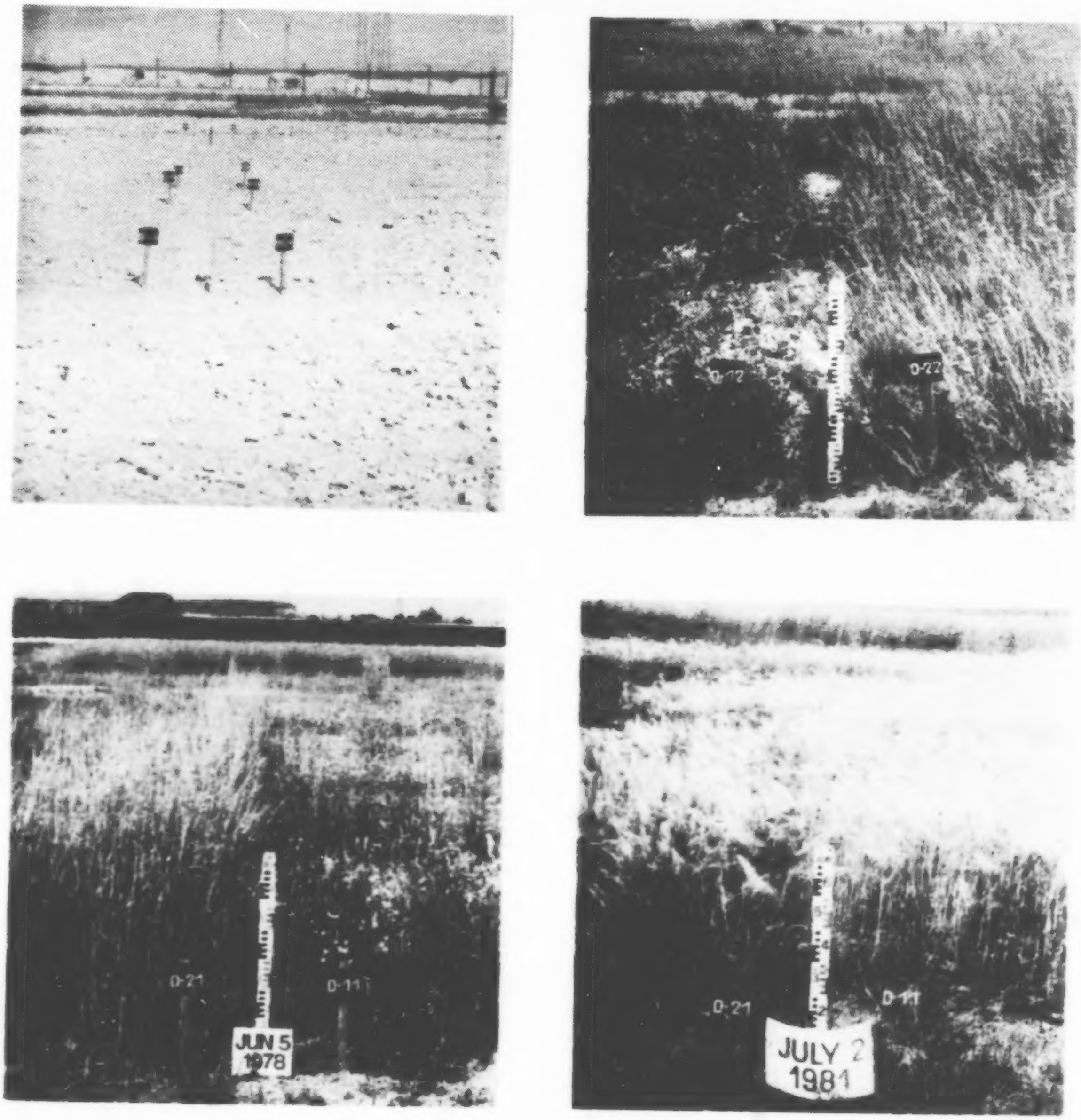

0-12
0-22
0-21
0-11
JUN 5
1978
0-21
0-11
JULY 2
1981

Figure 17. Field experiment in Konin. Ash with mineral fertilizers NPK in years 1976-1981. Crop rotation:

1975-1980: 0-11 (14) = mixture of holy clover with crown vetch
0-21 (24) = mixture of grasses with legumes
-1981: Winter barley.

1980-81 FIELD EXPERIMENTS ON BARLEY CULTIVATION

The final period of the research on agricultural reclamation of ash disposal areas was carried out on the usability of "ash soils" for cereal cultivation. Winter barley (Hordeum sativum) was selected as the test plant. For winter barley, the demands for soil cultivation and fertilization are quite high.

Halemba

The experiment was carried out as follows:

1. On August 14, 1980, all plots from the previous experiments were tilled to a depth of 15 cm to remove sod.
2. On August 16, 1980, prior to sowing, the plots were plowed and harrowed with heavy harrows, and larger patches of sod and couch grass were removed.
3. On August 18, 1980, phosphorus fertilizers were applied (90 kg/ha of P_2O_5 in the form of 46 percent triple superphosphate = 200 kg/ha of commercial fertilizer) and potassium fertilizers (100 kg/ha of K_2O in the form of 60 percent potash salt = 170 kg/ha of commercial fertilizer). After fertilization, plots were harrowed with light harrows.
4. On September 5, germinating weeds were removed by light harrowing.
5. On September 5, winter barley (*Hordeum sativum* - variety Dura OKW), (germination tested at 86%) - was seeded at the rate of 200 kg/ha using a drill seeder and harrowed with light harrows.
6. By October 15, germination of barley was sufficient, its growth and spreading were good after the snow cover melted.
7. On March 11, 1981, all plots were fertilized with nitrogen fertilizers--45 kg/ha of N in the form of 34 percent ammonium nitrate.
8. On May 8, 1981, the plots were refertilized with nitrogen fertilizer at the same rate. In March and April, growth of plants was not good, i.e., leaves dried and their ends became white. This condition was due to the spring drought; pollution of the air by dusts, sulfur, and fluorine; and the toxic ash base.

9. Since the barley had ripened earlier, on July 9, 1981, the crops were gathered and weighed, and samples of stalks and grains were taken for laboratory analyses. Results of these analyses are reported later.

Konin

The experiment on cultivation of winter barley (*Hordeum sativum*) was as follows:

1. On August 16, 1980, turf was removed with a rototiller to a depth of 20 cm from all plots on which grasses and legumes were cultivated. Prior to seeding, plots were deep-plowed and harrowed with heavy harrows.
2. On August 29, 1980, the remaining turf was removed by an active harrow (to a depth of 15 cm). Larger patches of turf were removed as well as couch grass.
3. On August 29, 1980, phosphorus mineral fertilizers (90 kg/ha of P_2O_5 in the form of 18 percent granulated superphosphate) were applied, as well as potassium fertilizers (100 kg/ha of K_2O in the form of 60 percent potash salt); then plots were harrowed with light harrows.
4. On August 29, 1980, winter barley was sown (variety Dura OKW) at 200 kg/ha. After the sowing, the plots were harrowed.
5. Observations on September 24, 1980, showed that germination was good and plants had begun to spread; however, older leaves were yellowing at their tops. The phenomenon was less intensive on plots covered with fertile soil (combinations A, B). The yellow color on the barley leaves was still observed the following spring. The sign indicated either insufficient amounts of nitrogen in the soil, damage due to the toxicity of the base ash, or pollution of the air by sulphur and fluorine compounds.
6. On March 17, 1981, all plots were treated with nitrogen fertilizers (45 kg/ha of N in the form of 34 percent ammonium nitrate).
7. On May 6, 1981, the plots were again fertilized with the same amount of nitrogen fertilizers. Observations revealed necrosis on leaves of cereals.

8. On July 7, 1981, photographs of plots with ripe barley were taken (Figures 15-17). The crop was gathered and weighed, and samples of straw and grains were taken for chemical analysis. The barley had ripened 2 weeks earlier than on the adjacent fields. Results of these measurements are presented in this report.

PREPARATION OF FIELD EXPERIMENTS FOR TREES AND SHRUBS

The forest-type reclamation study was carried out by using a method of independent series with one variable. The area was divided as follows:

- Four ash treatments, dependent on the method of ash preparation (four blocks)
- Ten combinations of trees and shrubs

Ash Treatments

In 1975, four ash treatments were applied in Halemba and in Konin. (See again Figures 10 and 11.)

1. Pits dug in the ash were treated with fertile soil and mineral fertilizers in the following proportions (per 1 m^3):

Ash	- 0.75 m^3
Fertile soil	- 0.25 m^3
Ammonium nitrate, 34% N	- 0.13 kg
Superphosphate, 46% P_2O_5	- 0.30 kg

2. Pits dug in the ash were treated with mineral fertilizers and tertiary sand (only at Konin) or bentonite (only at Halemba) in the following proportions (per 1 m^3):

Konin:

Ash	- 0.75 m^3
Tertiary sand	- 0.25 m^3
Ammonium nitrate, 34% N	- 0.13 kg
Superphosphate, 46% P_2O_5	- 0.30 kg

Halemba:

Ash	- 0.90 m^3
Bentonite	- 0.10 m^3
Ammonium nitrate, 34% N	- 0.13 kg
Superphosphate, 46% P_2O_5	- 0.30 kg

3. Pits dug in the ash were treated with high moor peat and mineral fertilizers in the following proportions (per 1 m^3):

Ash	- 1.00 m^3
High moor peat calculated as dry mass	- 8.00 kg
Ammonium nitrate, 34% N	- 0.13 kg
Superphosphate, 46% P_2O_5	- 0.30 kg

4. Pits dug in the ash were treated with mineral fertilizers in the following proportions (per 1 m^3):

Ash	- 1 m^3
Ammonium nitrate, 34% N	- 0.13 kg
Superphosphate, 46% P_2O_5	- 0.30 kg

Planting Combinations of Trees and Shrubs

Halemba (Figure 10)--

The following trees and shrubs were planted at Halemba:

Series	
I	Poplar robusta I (*Populus robusta* Schn.)
II	Poplar robusta II (*Populus robusta* Schn.)
III	White birch (*Betula verrucosa* Ehrh.)
IV	Black alder (*Alnus glutinosa* Geertn.)
V	Grey alder (*Alnus incana* Moench.)
VI	Locust tree (*Robinia pseudoacaccia* L.)
VII	European larch (*Larix decidua* Mill.)

VIII Pea shrub (*Caragana arborescens* Lam.)

IX Grey willow cross with basket willow (*Salix cinerea* L. x *S. viminalis* L.)

X Willow cuttings - Russel willow (Salix cross with rousseliana Willd = *Salix alba* cross with *Salix fragilis*).

Konin (Figure 11)--

The following trees and shrubs were planted at Konin:

Series

I Simon poplar (*Populus simonii* Carr.)

II Poplar robusta (*Populus robusta* Schn.)

III White birch (*Betula verrucosa* Ehrh.)

IV Grey alder (*Alnus incana* Moench.)

V Black alder (*Alnus glutinosa* Gaertn.)

VI Locust tree (*Robinia pseudoacaccia* L.)

VII Sharpleaf willow (*Salix Acutifolia* Willd.)

VIII Sea buckthorn (*Hippophae rhamnoides* L.)

IX Pea shrub (*Caragana arborescens* Lem.)

X Cuttings of late poplar (*Populus* cross with *serotina* Hart.).

Species of trees and shrubs were selected based on their resistance to toxic soil environment and air pollution, as well as their soil-forming properties.

Plot Preparation and Planting

At the disposal site in Konin, the ash was loosened to a depth of 75 to 150 cm with explosives.[7] The surface was levelled with a bulldozer and tilled to a depth of 0.40 m. At Halemba, grass and weeds were removed from the vicinity of the plots.

In the planting of the trees and shrubs, the following spacing was used:

Poplars - 3.0 x 3.0 m

Other types of trees - 1.0 x 1.0 m

Shrubs - 1.0 x 1.0 m

Poplar combined with willow cuttings - 1.0 x 0.5 m

The pits dug in the ash were of the following sizes:

Poplars - 0.7 x 0.7 x 0.7 m = 0.343 m^3

Other types of trees - 0.5 x 0.5 x 0.5 m = 0.125 m^3

Shrubs - 0.3 x 0.3 x 0.3 m = 0.027 m^3

The pits were backfilled with ash and the amendments described above. Because no rains occurred at the time, the trees and shrubs were irrigated once after planting, with 10 dm^3 for poplars and 5 dm^3 for all other species.

The plots for poplar and willow cuttings were treated with four variants as follows:

1) Covered with a 20-cm layer of fertile soil + fertilization as on the plots of agricultural-type reclamation (see again Table 7).

2) a. Covered with bentonite layer (100 m^3/ha) + mineral fertilization as on the plots of agricultural-type reclamation (Table 7)--only at Halemba.

   b. Covered with a layer of tertiary sand (500 m^3/ha) + mineral fertilization as on the plots of agricultural-type reclamation (Table 7)--only in Konin.

3) Treatment with the amendment of high moor peat (10 t/ha) + mineral fertilization, as on the plots of agricultural-type reclamation (Table 7).

4) Mineral fertilization as on the plots of agricultural-type reclamation (Table 7).

THE COURSE OF EXPERIMENTS WITH TREES AND SHRUBS, 1975-1981

Halemba

During the vegetation period of 1975, cultivation included mainly removing weeds around trees and shrubs by the use of machines.

The first planting of birch (Betula verrucosa), grey alder (Alnus incana) did not survive at Halemba, and new trees were planted on these plots. No fertilizers or neutralizers were added, and the new trees were planted in the same locations as the first plantings (on series III, V, and VII). New poplar trees were also planted in place of those lost in plant series II.

An additional test plot (XI) was developed at Halemba, where cuttings of poplar shoots were planted on the following four ash-treatment combinations:

- Plot XI-1-pits--covered with a 20-cm layer of fertile soil and fertilized with 130 kg/ha of P_2O_5 in the form of granulated triple superphosphate.
- Plot XI-2--pits mixed with 100 m^3/ha bentonite and fertilized with 130 kg/ha of P_2O_5 in the form of granulated superphosphate.
- Plots XI-3--pits mixed with 10 t/ha of high moor peat (calculated in terms of the air-dry mass) fertilized with 130 kg/ha of P_2O_5.
- Plot XI-4--pits mixed with 130 kg/ha of P_2O_5.

All plots were manually turned over and left for the winter without harrowing. In the spring of 1976, before the growing season, the area was raked and the poplar shoot cuttings were planted at a spacing of 1.0 x 0.5 m. Plots of the X series (willow shoot cuttings) and this new XI series (poplar shoot cuttings) were fed with nitrogenous fertilizers (50 kg/ha of N as urea).

In the spring of 1976, all the trees and shrubs were also supplied with nitrogenous fertilizers in the following doses (per tree or bush):

Plots of the series I and II (poplars)	- 55 g of N
Plots of the series III through IX (remaining types of trees and shrubs)	- 7 g of N per 1 cutting

In the fall of 1976, the plants were analyzed to determine the success of plantings, in terms of vigor and increments in height. Dead plants were replaced with new cuttings.

In the spring of 1977, the dead poplars and willows were also replaced. In 1977 and in the following years, the trees were not fed with mineral fertilizers, and the cultivation was limited to removal of weeds and hoeing to break up the crust on the surface of the "soil." Each year, plants were analyzed to determine their incremental growth in height and to assess their health. Photographs were also taken (e.g., Figures 18 and 19).

Konin

On about 50 percent of the trees planted at Konin, the first leaves dried shortly after the initial sprouting in the spring of 1975. Leaves reappeared on some plants in June; however, these also dried. The number of live specimens gradually decreased, so that by autumn, only the following specimens remained alive:

Series

I - Four specimens of poplar (with shoots and dry coronas
II - Eleven specimens of poplar
IV - One cutting of grey alder (with shoots)
VI - Three cuttings of locust tree
VIII - Four cuttings of sea buckthorn
IX - Twelve cuttings of pea shrub

By the end of the 1975 growing season, the cuttings survived as follows:

X-1 plot - Twenty-six shoot cuttings (of 40 planted) attained the height of 22-54 cm (average 35 cm)

X-2 plot - Eleven shoot cuttings attained the height of 5 to 52 cm (average 26 cm)

X-3 plot - Nine shoot cuttings attained the height of 10 to 35 cm (average 21 cm)

X-4 plot - Nine shoot cuttings attained the height of 13 to 26 cm (average 20 cm)

Because of these unsuccessful attempts to introduce trees and shrubs in the spring, caused by the drought and the high salinity of the ash, it was decided to repeat the experiment in

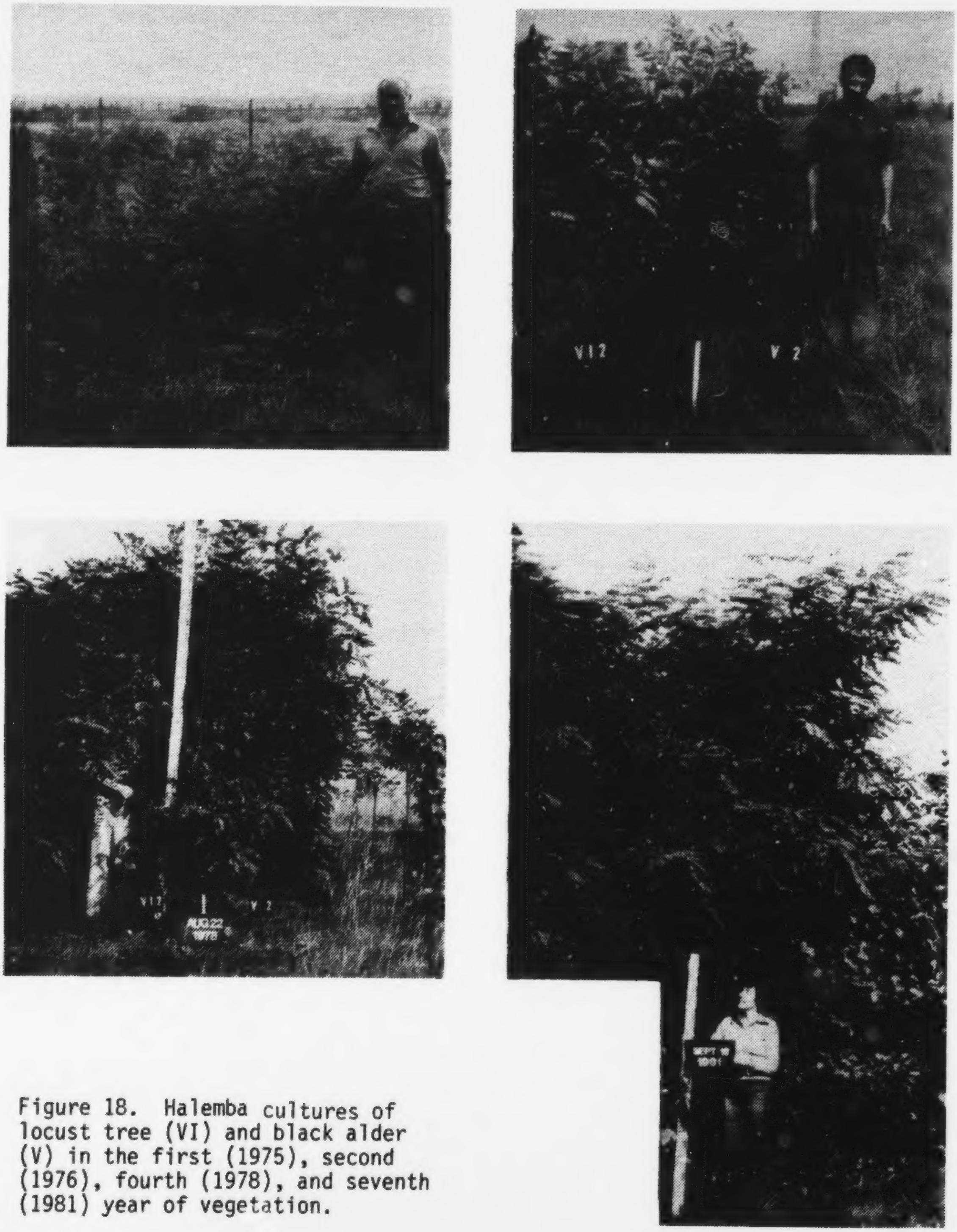

VI2
V 2
VI2
AUG.22
1978
V 2

Figure 18. Halemba cultures of locust tree (VI) and black alder (V) in the first (1975), second (1976), fourth (1978), and seventh (1981) year of vegetation.

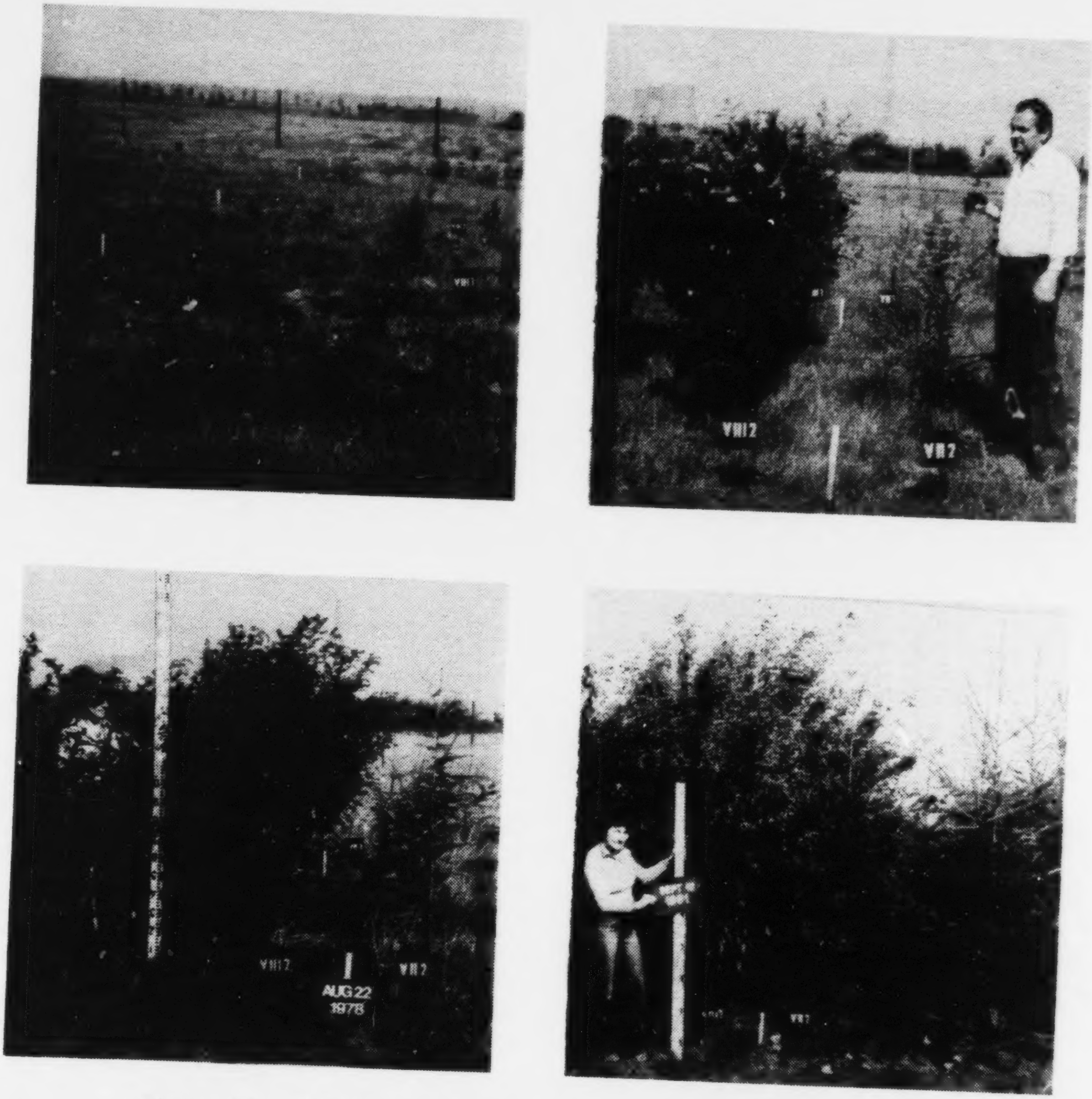
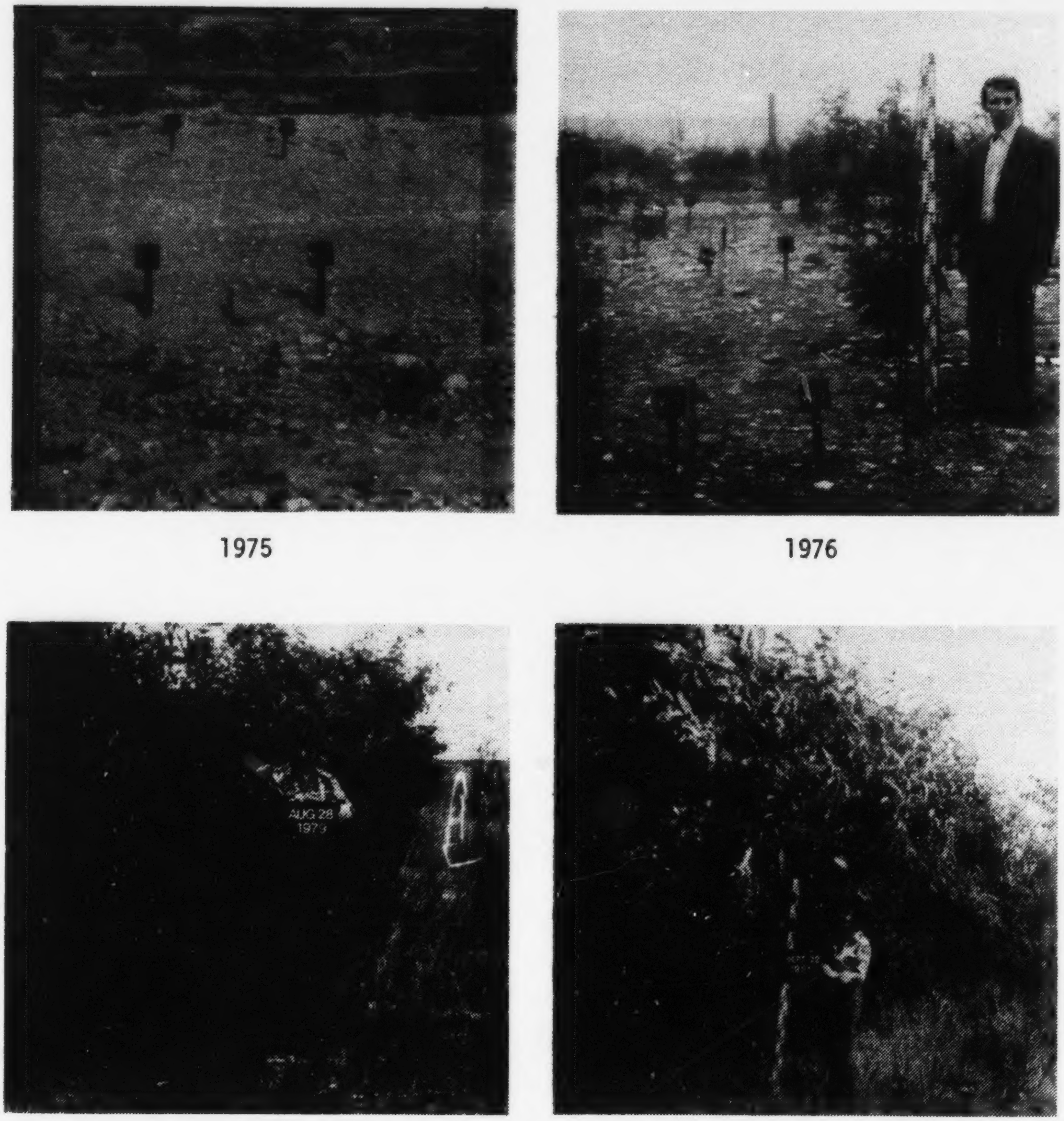

VIII2
VII2
VIII2
AUG 22
1978
VII2

Figure 19. Halemba cultures of larch tree (VII) and pea shrub (VIII) in the first (1975), second (1976), fourth (1978), and seventh (1981) year of vegetation.

the autumn of 1975 and to add a fifth combination of culture based on filling the pits entirely with soil. The pits for previous plants of trees and shrubs were completely dug out and filled with dressing prepared according to the treatments just described. Trees and shrubs (except larch) were planted a few days after preparation of the pits; larch was planted in the spring of 1976.

Since rainfall was low and temperatures were high in the spring of 1976, the cuttings were watered a few times. During the summer, areas around the trees were hoed and weeds were removed. In the autumn of 1976, measurements of growth and health were made. Dead plants were replaced with new plants.

The losses of poplar shoot cuttings (series X) were also made up by planting new cuttings during 1977. During the period 1977-1981 plants were analyzed each year to assess the number of losses, the health, and the growth increments. A photo record was kept (e.g., Figures 20 and 21).



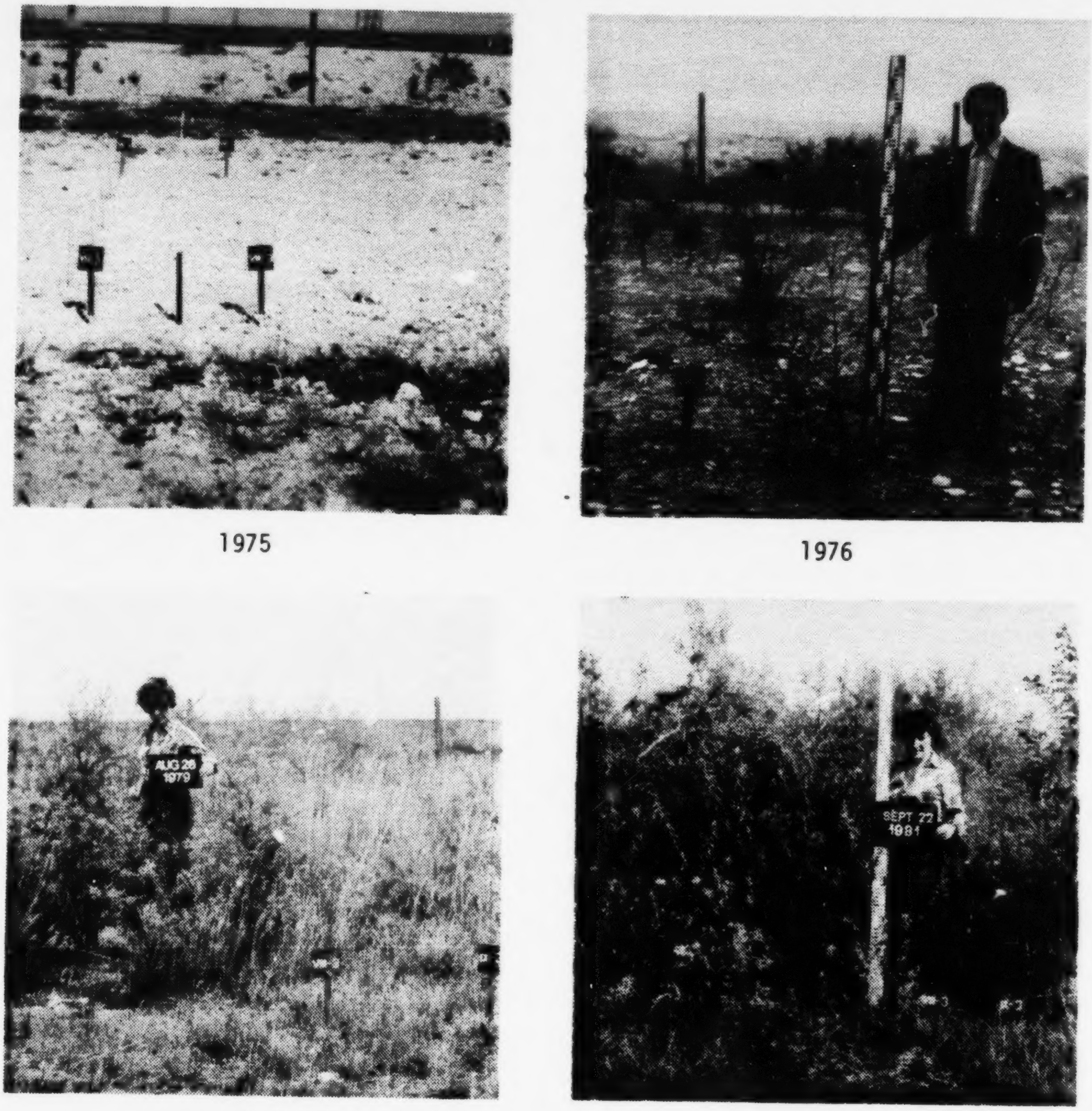
1975

1976

1977

1981

Figure 20. Konin cultures of locust tree (VI) in the first (1975), second (1976), fifth (1979), and seventh (1981) year of vegetation. Pits dressed with peat + NP.



AUG 28
1979
SEPT 22
1981

1975

1976

1979

1981

Figure 21. Konin cultures of sea buckthorn (VIII) in the first (1975), second (1976), fifth (1979), and seventh (1981) year of vegetation. Pits dressed with peat + NP.

SECTION 7

RESULTS

ASSESSMENT OF YIELDS

Pioneer Vegetation

The yields from the plots were determined by cutting and weighing the vegetation above the ground. Representative samples were taken for chemical analyses from each combination. Samples were weighed, dried at air temperature, and reweighed to determine the moisture content. These data are presented in the Appendix and summarized here.

Halemba--

For the 6-year period 1975-80 the best crops of hay (50.14 t/ha) were obtained from Plot A-2, which, in 1975, was covered with a 20-cm layer of fertile soil, seeded with a mix of grasses and legumes, and fertilized every spring and after the first cutting (Table 8). Some plots that were prepared in the same way but not fertilized during 1976-80 gave a total yield as low as 26.25 t/ha.

On control plots (00), where no fertilizers had been applied, seeds did not germinate at all; thus, the yield was zero. In 1976, these plots were treated with mineral fertilizers and reseeded. The total yield from these plots in the period 1976-80 was 24.41 t/ha of hay with the combination mentioned above (plot 0-2). The 6-year yield of hay from normal average fertile soil would be 18 to 60 t/ha under Polish conditions. Based on this criterion, one can state that crops gathered from the plots are within normal range of agricultural production (21.41 to 50.14 t/ha).

Some plots were not treated with mineral fertilizers after 1977. The highest total yield of hay from these plots (38.63 t/ha) was gathered from plot B-2, which was covered with a 10-cm layer of fertile soil and fed with mineral fertilizers in the years 1975-76, and then seeded with a mix of grasses with legumes. A number of plots gave a total yield lower than the mentioned criterion of 18 t/ha. This is particularly true of combinations where melilot is cultivated in pure sowing and

TABLE 8. AVERAGE HAY YIELDS FROM FERTILIZED PLOTS AT HALEMBA

Cultivation fertilization block	Description of plot treatment	Total yield in years 1975-80, t/ha	Ratio to the highest yield (A=100)
A	Ash + 20-cm layer of fertile soil + NPK	41.33	100.0
B	Ash + 10-cm layer of fertile soil + NPK	33.84	81.9
C	Ash + 5-cm layer of fertile soil + NPK	28.79	69.7
D	Ash + bentonite + NPK	24.24	58.6
E	Ash + low moor peat + NPK	32.62	78.9
F	Ash + high moor peat + NPK	24.10	58.3
G	Ash + farm manure + NPK	23.26	56.3
H	Ash + N2PK	28.48	68.9
I	Ash + NPK	23.43	56.7
0	Ash + NPK only in years 1977-80	25.69	62.2
00	Pure ash (control)	0.00	0.0

combinations that were not treated with larger quantities of organic substances. The lowest yields, 11.74 t/ha, were gathered from plots which had not been fertilized in the period 1977-80 and were seeded with melilot.

Comparison of total yields (Table 8) showed that the highest yields (41.33 t/ha) were obtained from plots covered with a 20-cm layer of fertile soil. The remaining combinations, where organic substances had not been applied, provided yields of 56.7 to 68.9 percent of that of crops from the combination covered with a 20-cm layer of fertile soil. Decreasing the thickness of the soil layer lowered the yields considerably.

Total yields obtained from individual types of pioneer plant mixtures fed with mineral fertilizers were compared (Table 9). Melilot gave the highest yields (combination 4); however, its average was obtained from 3 plots fertilized with fertile soil, while the remaining averages represent a wider complex (7 or 10 combinations).

Results of crops gathered from plots that received no fertilization in 1977-80 were as follows:

- 32 percent lower yields on plots seeded with a mix of alfalfa and melilot (combination 1).
- 38 percent lower yields on plots seeded with a mix of grasses and legumes (combination 2).
- 44 percent lower yields on plots seeded with alfalfa and orchard grass (combination 3).
- 35 percent lower yields on plots seeded with melilot.

The effect of annual fertilization on yields of pioneer plants is presented in Table 10. The most serious effects were observed on areas treated with organic matter. A major increase in yields on plots where a double dose of mineral fertilization was added would suggest that if doses of fertilizer were increased, even better crops could be obtained on the cultivational block H.

Konin--

In 1975, the first year of research, no crops were obtained because of a drought and the toxic effect of formed "ash-soil" on plants. In the period 1976-80, the highest yields (total) were obtained from plots seeded with a mix of grasses and legumes and plots cultivated on ash covered with a 20-cm layer of fertile soil + NPK, and fertilized every year, with mineral fertilizers in the spring and after the first harvest (45.38 t/ha). The crops were relatively good compared against the criterion (Normal Agricultural Practices) mentioned above (18 to 60 t/ha). From

TABLE 9. AVERAGE YIELDS OF HAY FROM PLOTS AT HALEMBA, BASED ON THE TYPE OF PIONEER PLANTS

Number of mixture	Type of pioneer plants	Total yield in years 1975-80, t/ha	Ratio to the highest yield (4=100.0)
	Plots fertilized in years 1975-1980		
1	Alfalfa with meliot	28.26	84.8
2	Mix of grasses and legumes	29.69	89.1
3	Mix of alfalfa and orchard grass	26.27	78.9
4	White melilot	33.32	100.0
	Plots without fertilization in years 1977-1980		
1	Alfalfa with melilot	19.24	89.0
2	Mix of grasses and legumes	18.42	85.2
3	Mix of alfalfa and orchard grass	14.84	68.7
4	White melilot	21.61	100.0

TABLE 10. AVERAGE YIELDS OF HAY FROM PLOTS WITHOUT ANNUAL MINERAL FERTILIZATION--HALEMBA

Cultivation fertilization block	Description of plot treatment in 1975	Total yield in years 1975-80, t/ha	Ratio to the highest yield (A=100)	Yield decrease compared with fertilized plots, %
A	Ash + 20-cm layer of fertile soil + NPK	20.84	100.0	49.6
B	Ash + 10-cm layer of fertile soil + NPK	19.10	91.7	43.6
C	Ash + 10-cm layer of fertile soil + NPK	18.54	89.0	35.6
D	Ash + bentonite + NPK	18.11	86.9	25.3
E	Ash + low moor peat + NPK	17.66	84.7	45.9
F	Ash + high moor peat + NPK	16.77	80.5	30.4
G	Ash + farm manure + NPK	19.30	92.6	17.0
H	Ash + N2PK	15.63	75.0	45.1
I	Ash + NPK	16.65	79.9	29.0
0	Ash + NPK in 1976	14.74	70.7	42.6
00	Ash without fertilization	0.00	x	x

plots that had not been fertilized with mineral substances in the years 1977-80, total crop was many times lower (16.51 t/ha) on the same cultivation block with the same pioneer vegetation. The lowest crops were gathered from the following:

- Plots fertilized every year since 1976 with holy clover and crown vetch (20.53 t/ha).
- Plots without mineral fertilization in years 1977-80.

The average highest yields (total for years 1975-80 = 40.46 t/ha) were obtained from pioneer plants cultivated on ash-covered plots with a 10-cm layer of fertile soil (B). Yields gathered from plots covered with a thicker layer of soil (A) were 4.7 percent lower (Table 11). The lowest yields were obtained from control plots (0), where top-dressing with mineral fertilizers was used from 1976.

Yields were 55.7 percent lower without annual mineral fertilization (Table 12), which proves the positive effect of the fertilization treatment. The use of mineral fertilizers, however, reduced the nutrition value of the hay because of the loss of legumes, which have a high protein content in the mixture. The fodder value of the hay is presented in the Appendix.

Among four combinations of pioneer plant mixtures (Table 13), the highest yields were obtained from plots seeded with a mix of grasses and legumes (combination 2), i.e., 36.99 t/ha. The worst results were from combination 1 (holy clover + crown vetch), in which the yields were 37 percent lower than on combination 2. Combination 3, a mixture of alfalfa + melilot, gave the best yields (19.46 t/ha) without complementary top-dressing. The yields of crops in the remaining combinations were lower than those obtained from cultivated soils.

The yields of crops gathered from sulphate-calcium ashes at Konin generally were 14 percent higher than those of crops from bituminous coal ashes at Halemba (Table 14).

Cereals

Cereals seeded after the pioneer plant forecrop were harvested, dried, and weighed (both straw and grains). The results, which are presented in the Appendix, are summarized here.

Halemba--

The hypothesis that all plots with nonfertilized pioneer plants as a forecrop before planting of winter barley would have a lower barley yield did not prove to be true. Grass growing on fertilized plots forced out legumes or the nitrogen retarded legume growth. Therefore, the soil formed was less rich in nitrogen, which was a decisive factor for subsequent crops. On

TABLE 11. AVERAGE YIELDS OF HAY FROM FERTILIZED PLOTS--KONIN

Cultivation fertilization block	Description of plot treatment	Total yield in years 1975-1980, t/ha	Ratio to the highest yield (B=100)
A	Ash + 20-cm layer of fertile soil + NPK	38.56	95.3
B	Ash + 10-cm layer of fertile soil + NPK	40.46	100.0
C	Ash + 5-cm layer of fertile soil + NPK	32.19	79.6
D	Ash + tertiary sand + NPK	31.87	78.8
E	Ash + low moor peat + NPK	32.76	81.0
F	Ash + high moor peat + NPK	30.22	74.7
G	Ash + farm manure + NPK	34.92	86.3
H(K)	Ash + N2PK + green manure	30.22	74.7
I	Ash + NPK	29.53	73.0
0	Ash + NPK in 1976	24.96	61.7
00	Pure ash	0.00	0.0

TABLE 12. AVERAGE CROPS OF HAY FROM PLOTS WITHOUT ANNUAL MINERAL FERTILIZATION--KONIN

Cultivation fertilization plot	Description of treatment in 1975	Total crops in years 1975-80, t/ha	Ratio to the highest crop (G=100)	Crop decrease compared with fertilized plots
A	Ash + 20-cm layer of fertile soil + NPK	15.76	87.5	59.1
B	Ash + 10-cm layer of fertile soil + NPK	17.46	96.9	56.8
C	Ash + 5-cm layer of fertile soil + NPK	14.43	80.1	55.2
D	Ash + tertiary sand + NPK	12.26	68.1	61.5
E	Ash + low moor peat + NPK	13.58	75.4	58.5
F	Ash + high moor peat + NPK	14.41	80.0	52.3
G	Ash + farm manure + NPK	18.01	100.0	48.4
H(K)	Ash + N2PK + green manure	15.42	85.6	49.0
I	Ash + NPK	13.32	74.0	54.9
0	Ash + NPK in 1976	9.73	54.0	61.0
00	Pure ash	0.00	0.0	X

TABLE 13. AVERAGE YIELDS OF HAY FROM PLOTS AT KONIN, BASED ON THE TYPE OF PIONEER PLANTS

Number of mixture	Type of pioneer plants	Total yield in years 1975-80, t/ha	Ratio to the highest yield[a]
Plots fertilized in years 1975-1980			
1	Holy clover with crown vetch	23.52	63.6
2	Mix of grasses and legumes	36.99	100.0
3	Alfalfa with orchard grass	35.38	95.6
4	White melilot	29.59	80.0
Plots not fertilized in years 1977-1980			
1	Holy clover with crown vetch	10.09	51.8
2	Mix of grasses and legumes	13.21	67.9
3	Alfalfa with orchard grass	19.46	100.0
4	White melilot	11.94	61.4

[a] Mixture 2 is 100 for plots fertilized in years 1975-1980. Mixture 3 is 100 for plots not fertilized in years 1977-1980.

plots not fertilized in forecrop cultivation, legumes dominated, which favorably affected the yield of subsequent plants. This finding was confirmed on a considerable number of plots.

TABLE 14. YIELDS OF PIONEER PLANTS AT HALEMBA AND KONIN

Type of ash	Average total yield[a] in years 1975-1980, t/ha	
	Plots fertilized in years 1975-1980	Plots not fertilized since 1977
Silicon-aluminum from burning bituminous coal in Halemba	25.58	17.74
Calcium-sulfate from burning lignite in Konin	32.56	14.44

[a] All plots.

The highest ratio of grain/straw (0.43) was obtained on plot A-3, which was covered with a 20-cm layer of fertile soil and had cultivated grasses and legumes as a forecrop. The lowest ratio (0.21) was found on plot C-4, which was covered with a 5-cm layer of fertile soil (after melilot as a forecrop). The ratio of grain/straw can be affected not only from grain weight, but also from the amount of weeds in the straw. Conditions were particularly favorable for weeds on plots covered with a thin layer of fertile soil, bentonite, and peat, i.e., where cereal growth was weakest.

The highest yields of winter barley grain were gathered from plots covered with a 20-cm layer of fertile soil (2.05 to 4.2 t/ha), compared with the average yield in Poland (3 t/ha). The lowest yields of grain (0.78 t/ha) were gathered from plot C-4, which was covered with a 5-cm layer of fertile soil and had melilot as a forecrop.

Table 15 shows yields of barley based on the method of plot treatment before forecrop cultivation in 1975. The average highest yield (3.39 t/ha) was gathered from plots on block A, covered with a 20-cm layer of fertile soil. The lowest yield (block F, with 0.74 t/ha) was due to weeds, which overgrew the barley.

TABLE 15. EFFECT OF THE METHOD OF ASH TREATMENT BEFORE SEEDING FORECROP (1975) ON WINTER BARLEY YIELDS (1981)

Cultivation fertilization block	Description of plot treatment	Grain crop t/ha	Ratio to the highest crop (A=100)	Grain crop, t/ha	Ratio to the highest crop (A=100)
A	Ash + 20-cm layer of fertile soil + NPK	3.39	100.0	2.89	100.0
B	Ash + 10-cm layer of fertile soil + NPK	2.74	80.8	2.41	83.4
C	Ash + 5-cm layer of fertile soil + NPK	1.49	44.0	2.49	86.2
D	Ash + bentonite + NPK	1.49	44.0	-	-
	Ash + tertiary sand + NPK	-	-	2.23	77.2
E	Ash + low moor peat + NPK	2.73	80.5	2.16	74.7
F	Ash + high moor peat + NPK	0.74	21.8	2.29	79.2
G	Ash + farm manure + NPK	1.94	56.0	2.12	73.4
H	Ash + N2PK	2.40	70.8	-	-
	Ash + N2PK + green manure				
I	Ash + NPK	2.15	63.4	2.81	97.2
0	Ash + NPK in years 1976-81	2.31	68.1	2.10	75.8
	Average	2.13	-	2.39	-

The average yield for all plots at Halemba (2.13 t/ha) was 12 percent lower than the average yield at Konin (2.39 t/ha), and was about 70 percent of the average crops gathered in Poland in 1981 (3.0 t/ha). From the national viewpoint, crops obtained from blocks A, B, and E can be considered comparable to crops obtained under natural conditions. These blocks were treated with larger amounts of organic substances in 1975.

Konin--

The highest weight ratio of grain to straw (0.53) was achieved on plot B-2, which was covered with a 5-cm layer of fertile soil (forecrops was a mixture of grasses with legumes). The lowest ratio was obtained by plot C-4, which was covered with a 5-cm layer of fertile soil (forecrop was white melilot). This result was similar to that found at Halemba. The plots at Halemba were not infested with weeds, but the soil was less fertile.

The highest crop yields of barley grains (3.26 t/ha) were gathered from the plot covered in 1975 with a 20-cm layer of fertile soil after a forecrop mixture of grasses and legumes, similar to Halemba. The lowest crop yields were gathered from the control plot 0-2, fertilized since 1976 and with a forecrop mixture of grasses and legumes. Crops comparable to those obtained under natural conditions (3.0 t/ha for Poland) were obtained from plots of block A, which were seeded with a mix of grasses and legumes (3.26 tons/ha) or melilot (2.18 t/ha), and from plots of block I (NPK applied as starting fertilization and as top dressing for forecrop since 1975), which was seeded with holy clover and crown vetch as a forecrop (2.95 t/ha) or with a mix of alfalfa and orchard grass (3.00 t/ha). The remaining crops were 60 to 95 percent of the average Polish yields gathered in 1981.

At Konin, yields on crops of grain and straw gathered from plots top-dressed in the years 1975-80 generally averaged 36 percent higher than yields on crops from plots not fertilized in years 1977-80.

It can be concluded that cereals can be cultivated after the forecrop of grasses and legumes on soils fed with larger amounts of organic substances (fertile soil, low moor peat, green manure) and mineral fertilizers.

CHEMICAL QUALITY OF CROPS

The usefulness of the plants gathered from experimental plots was assessed based on laboratory analyses of the barley grain and straw and the hay from the forecrop. Results of the analyses are presented in tables in the Appendix and summarized below.

Nutritive Value of Hay From Forecrops

The criteria by which the hay is judged as fodder for animals, presented in Tables 16 through 19, were based on Polish agricultural literature.[33,37]

Protein--

The protein content of hay is the fundamental criterion of its nutritive value (Table 16). The results of the protein analysis are shown in Figures 22 and 23. On all combinations, the protein content was higher than the recognized acceptable values of 63 g/kg (dry wt.). The standard protein content in alfalfa, also cultivated on the plots, is 250 g/kg of dry mass, with variations ranging from 194 to 320 g.[34] The protein content in the mix of grasses and legumes harvested from experimental plots was as high as 210 g (Halemba - Figure 22) and 220 g (Konin - Figure 23). The content of protein varied widely, depending on the time of hay harvesting and the combination and type of pioneer plant mixture. A large decrease of protein content was observed at Halemba (Figure 22) as the cultures got older. This decrease is connected with the loss of legumes in the mixture due to mineral fertilization. The highest total protein mass (6220 kg/ha) was obtained in Halemba from plot A-2, which was covered with a 20-cm layer of fertile soil and seeded with a mix of grasses and legumes. The yield of protein decreased as the thickness of fertile soil decreased:

° At a thickness of 10 cm	- 4218 kg/ha
° At a thickness of 5 cm	- 4061 kg/ha
° Without fertile soil (plot I-1)	- 3111 kg/ha

Similar results were obtained on experimental plots at Konin. The highest yields of protein (total in years 1975-80) were obtained from plots covered with fertile soil and seeded with a mix of alfalfa and orchard grass:

° At a soil-layer of 20 cm	- 4581 kg/ha
° At a soil-layer thickness of 10 cm	- 4464 kg/ha
° At a soil-layer thickness of 5 cm	- 3497 kg/ha
° Without fertile soil (plot I-3)	- 3081 kg/ha

The lowest yields of protein were obtained at Halemba from plot F-3 fertilized with high moor peat and seeded with white melilot (2493 kg/ha); and at Konin from plots H-1 fertilized with a double dose of mineral fertilizers and seeded with a mix of holy clover with crown vetch.

TABLE 16. CONTENT OF MACROCOMPONENTS IN HAY (ASSESSMENT CRITERIA)

	Content in hay, percent	
Component	Good	Poor
Protein	6.3	-
K_2O	2.0	0.2 - 1.8
P_2O_5	0.5	0.2 - 0.4
CaO	1.0	

TABLE 17. TYPICAL CONTENT OF MACRO- AND MICROCOMPONENTS IN DRY MASS OF ALFALFA GATHERED FROM CULTIVATED SOILS (POLAND)

	N	P_2O_5	K_2O	CaO	Mg	Mn	Cu	B	Mo	Zn	Fe	Co
	Percent					ppm						
Average	4.0	0.82	3.30	3.27	0.25	35.8	10.4	36.0	0.68	39.0	160	0.13
Minimum	3.1	0.46	1.83	2.63	0.12	26.3	5.6	25.5	0.01	28.8	117	0.05
Maximum	5.1	1.05	4.99	4.32	0.32	60.2	18.8	54.0	2.76	50.2	244	0.29

TABLE 18. CONTENT OF TRACE ELEMENTS IN SOILS AND PLANTS AND ANIMAL DEMANDS
(ppm)

	Cu	Mn	Fe	Co	B	Zn	Mo
Soil	50-60	3000	400-3000	1-50	40	250	2-20
Plants	4-15	10-2000	3000	0.05-0.2	50-70	10-150	0.01-8.8
Hay for animals	6-12	30-100	30-100	30-50	0.06-0.1	40-80	1-1.5

TABLE 19. SELECTED PROPERTIES OF FODDER PLANTS GATHERED FROM CULTIVATED SOILS

Component	Grasses	Legumes	Weeds
Ash	5.6	8.6	9.4
Magnesium (Mg)	0.665	0.895	-
MgO	(1.10	(1.48)	
Sodium (Na)	0.080	0.080	0.155
(Na_2O)	(0.11)	(0.11)	(0.21)
Sulfur (S)	0.655	0.50	0.92

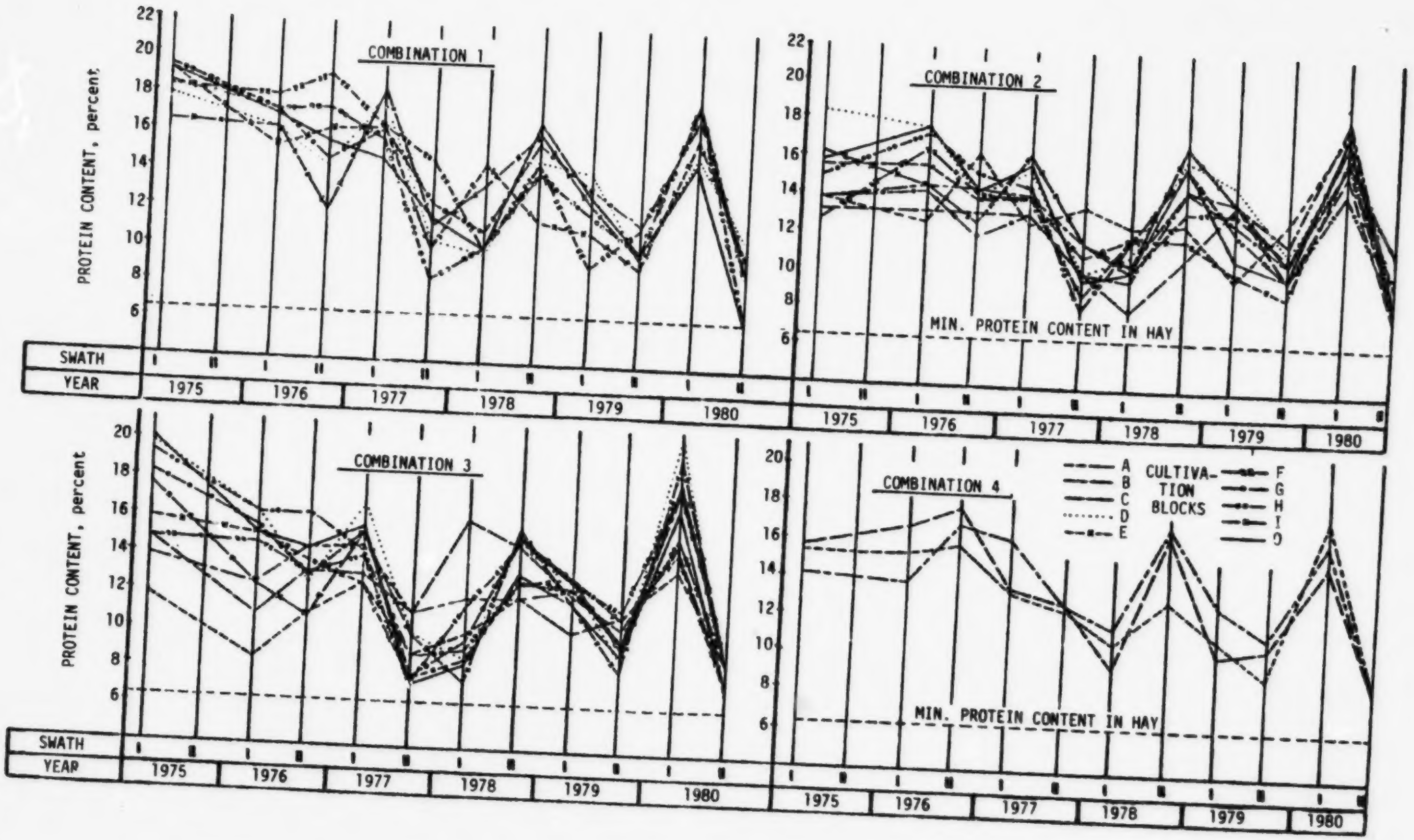


Figure 22. Protein content of hay crop--Halemba.

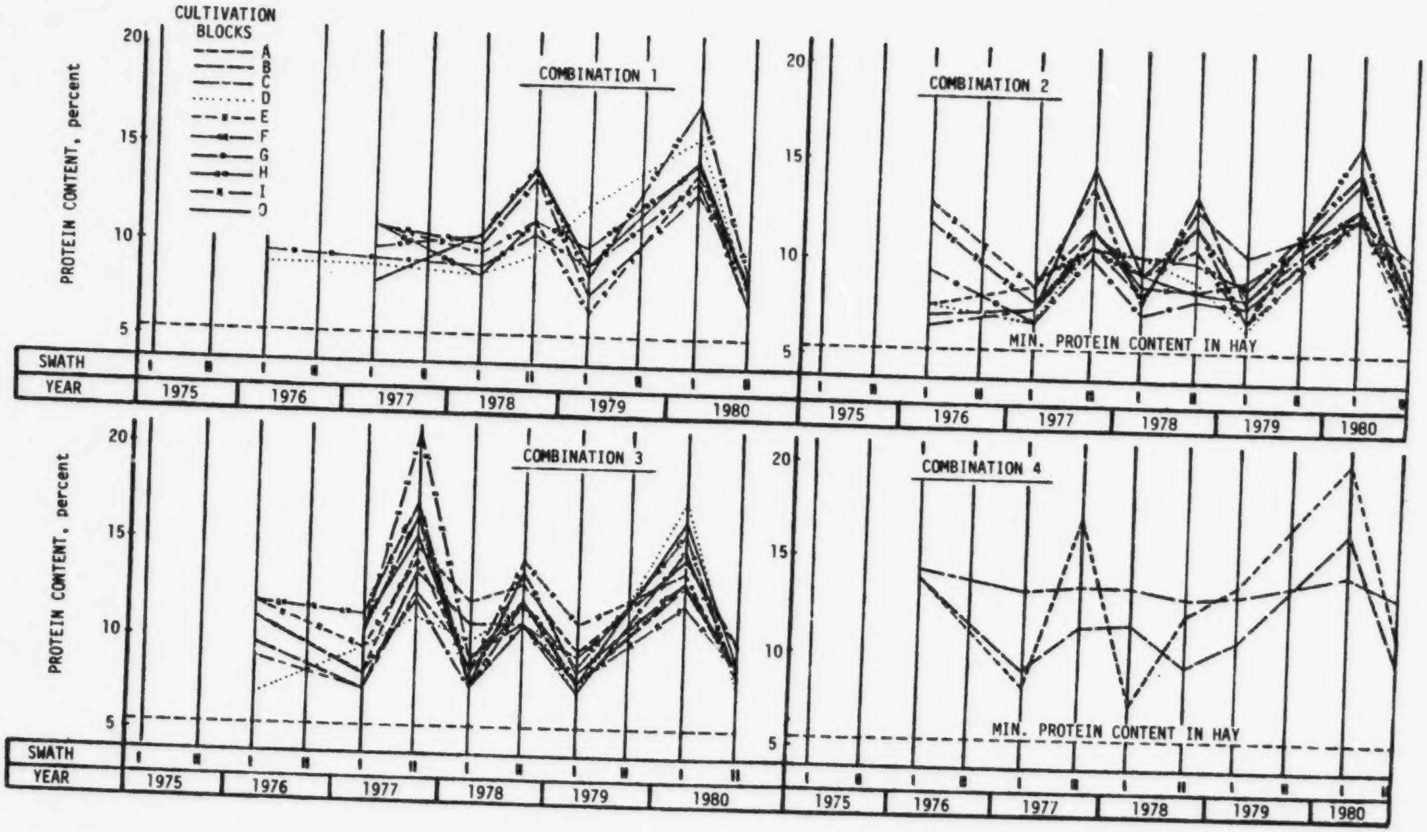


Figure 23. Protein content of hay crop--Konin.

Ash--

The content of ash in hay crops varied from 4 to 14 percent (Halemba) and from 3.5 to 10 percent (Konin). The data on ash mass per hectare is presented in the appendix. The highest total mass of ash (in years 1975-80) was gathered from plots of the highest hay yields. In Halemba 3763 kg/ha of ash was collected from plot A-2 covered with a 20-cm layer of fertile soil and seeded with a mix of grasses and legumes. In Konin the highest mass of ash (3215 kg/ha) was gathered from plot E-2 fertilized with low moor peat and seeded with a mix of grasses and legumes. The smallest amounts of ash in Halemba (1606 kg/ha) were gathered from plot F-2 fertilized with peat and seeded with a mix of grasses and legumes, and in Konin (1707 kg/ha) from plot F-1 fertilized with high moor peat and seeded with a mix of holy clover with vetch. Variations of ash content on selected combinations A-2 and 0-2 are presented in Figures 24 and 25. Variations of ash content are probably somewhat dependent on dust fallout.

Phosphorus P_2O_5--

The content of P_2O_5 in good hay should be at least 0.5 percent (Table 16). Laboratory analyses showed that the content of P_2O_5 in hay gathered from plots at Halemba varied from 0.4 to 0.75 percent, and the content in hay from plots in Konin varied from 0.2 to 0.65 percent. This finding would indicate that sufficient P_2O_5 content is available (Figures 24 and 25). This variation depends not only on soil richeners, but also on the time of harvesting and other factors. Comparison of the P_2O_5 data in the appendix indicates that the highest absorption of phosphorus from soil was observed at the highest yields.

At Halemba, the highest production of P_2O_5 (320 kg/ha in years 1975-80) was observed on plot A-2, which was treated with a 20-cm layer of fertile soil and seeded with a mix of grasses and legumes. The lowest production (120 kg/ha) was on plot F-3, which was fertilized with high moor peat and seeded with melilot. Absorption of P_2O_5 was inversely proportional to the reserve of P_2O_5 in the formed soil calculated at the end of the year 1980. The highest production at Konin (289 kg/ha in years 1975-80) was observed also on plots A-2, whereas the lowest values were found on control plot 0-1, which was seeded with a mix of holy clover and crown vetch.

Potassium (K_2O)--

Absorption of potassium was highly dependent on its reserves in formed soil. In the initial period, plants were absorbing potassium contained in the ash; however, in the second and third year of reclamation, a lack of potassium was already evident. Mineral fertilization in the fourth and fifth years increased not only yields, but also the K_2O contribution in the hay mass (Figures 25 and 26).

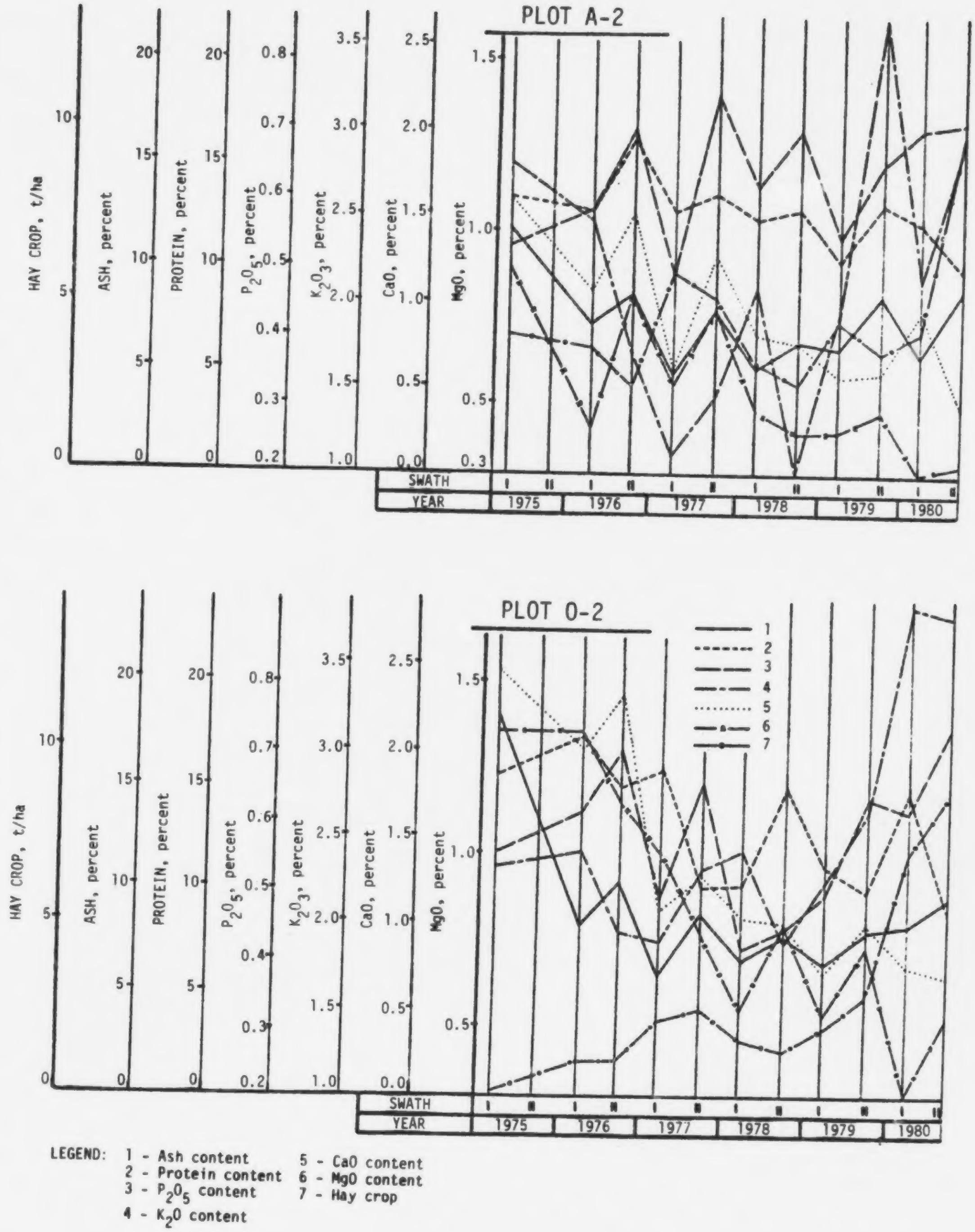


Figure 24. Physicochemical properties of hay gathered from plots A-2 and O-2 at Halemba.

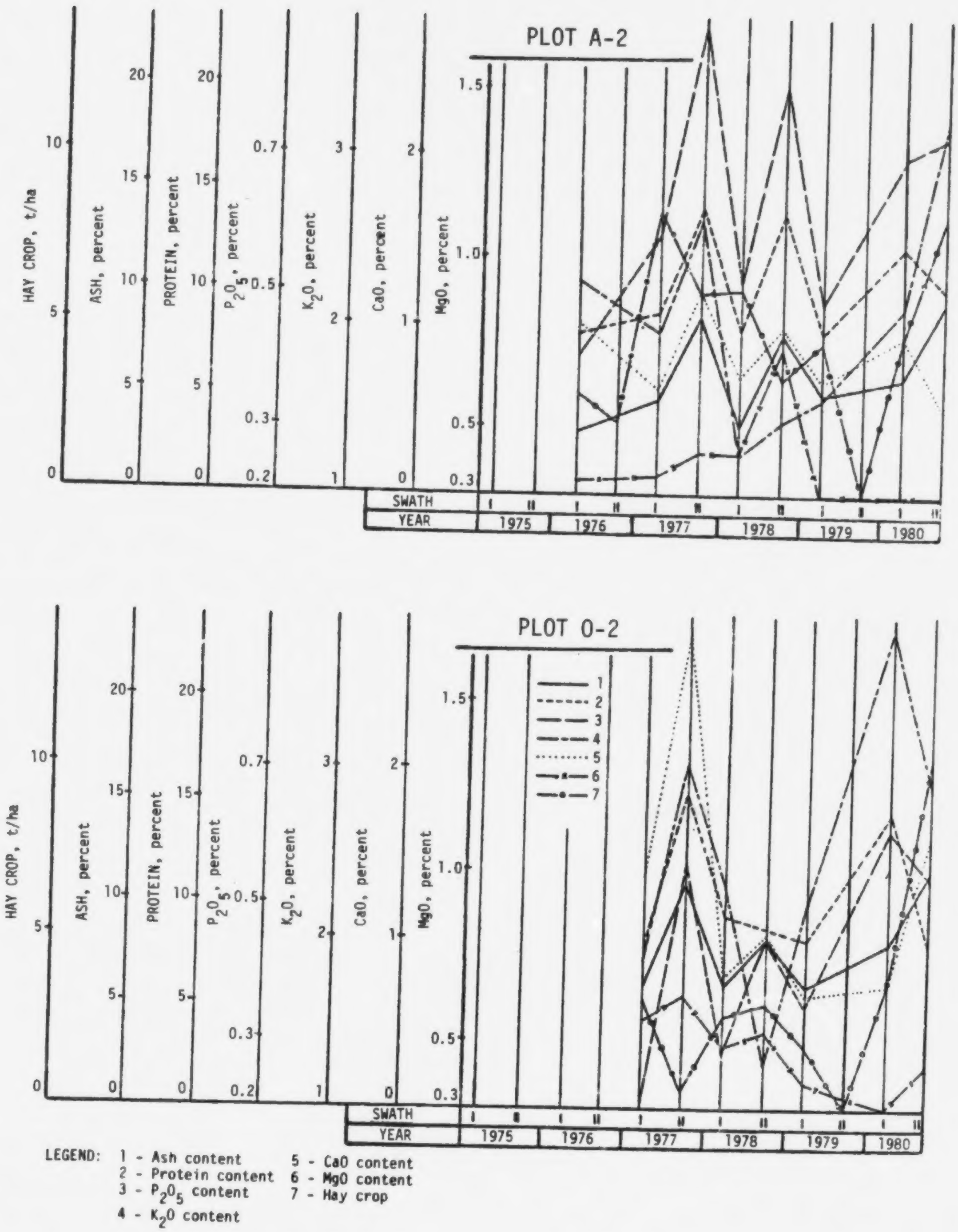


Figure 25. Physicochemical properties of hay gathered from plots A-2 and O-2 at Konin.

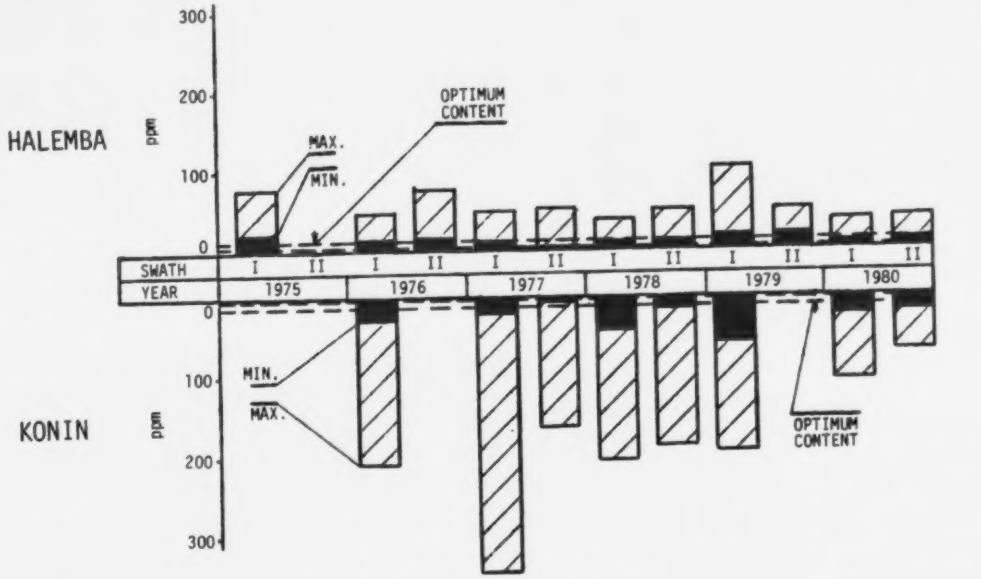


Figure 26. Variations in B content of hay from pioneer plants.

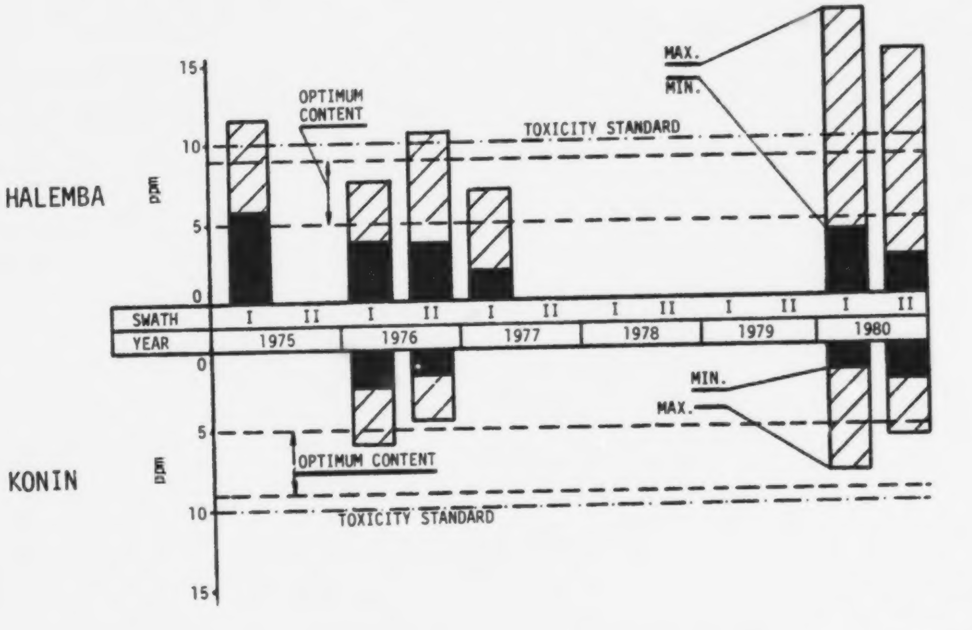


Figure 27. Variations in Cu content of hay from pioneer plants.

The content of potassium in dry mass of hay varied from 1 to 3.8 percent at Halemba and from 1.3 to 4 percent at Konin. The standard potassium content in good hay (Table 16) was 2 percent.

The most intensive production of K_2O (1123 kg/ha in years 1975-80) was observed at Konin on plot G-3, which was treated with farm manure and seeded with a mix of alfalfa and orchard grass. Production of K_2O in 1980 was 100 percent (380 kg/ha) potassium applied in mineral fertilizers. In Halemba, on plot A-2 fertilized with fertile soil (20-cm layer) and seeded with a mix of grasses and legumes in 1980, plants produced 456 kg/ha of K_2O at a fertilization rate of 380 kg/ha. The content of K_2O in the hay in that same year increased to the record value of 4 percent (Figures 24 and 25).

Calcium (CaO)--

The CaO content in hay crops varied from 0.4 to 1.6 percent at Halemba and from 0.6 to 2.6 percent at Konin. The latter value refers to control plot 0-2, which was seeded with a mix of grasses and legumes (Figure 25). The high calcium content in the calcium-sulphate ashes produced at Konin produced only a slight increase in the content in the crops. The average production of CaO at Halemba was 256.5 kg/ha; at Konin, it was 24 percent lower. A comparison of the CaO content in hay (Table 16) and that in alfalfa (Table 17) against standard values shows that a considerable number of plots produced hay with insufficient CaO. Crops gathered from Halemba were even poorer.

Magnesium--

The high content of magnesium in the ashes resulted in an elevated content in hay crops (Figures 24 and 25). At Halemba, the values varied from 0.3 to 1.6 percent (higher in crops from pure ashes than from plots covered with fertile soil) and from 0.3 to 0.75 percent at Konin. Tables 17 and 19 show how divergent opinions of various scientists are about the optimum MgO content in hay (from 0.25 to 0.895 percent of Mg and from 0.41 to 1.49 percent of MgO).

Soluble Boron--

A high concentration of boron was found in the hay as a result of the high concentration in the ashes. The highest concentration of boron (350 ppm) was found at Konin in crops harvested in the spring of 1977 from plot I-1, which had been fed with mineral fertilizers and seeded with a mixture of holy clover and crown vetch. A relatively lower (however, still quite high) concentration of boron was noted in crops gathered from plots covered with fertile soil (5.3 ppm from plot A-4 in 1977). Crops from "ash soils" at Halemba contain from 1.6 to 104 ppm of boron (Figure 26). The content of boron decreased with time, and in 1980 only 103 ppm was noted at Konin (plot H-1) and 36 ppm at Halemba (plot H-3).

Copper--

The concentration of copper in plants was 2 to 18 ppm at Halemba and 1.5 to 8 ppm (Figure 27) at Konin. At first the excessive content of Cu was observed in crops from plots covered with fertile soil (A-4) at Halemba, which was due to the presence of the element in the soil. In 1979, plots were fertilized with microelements and macroelements that immediatley resulted in increased Cu content in the crops (up to 18 ppm).

In 1979, the content of copper at Konin also was changed (from 1.5 to 6 ppm) by adding microelements.

Manganese--

A high level of manganese (215 ppm) was found only in the first year at Halemba. The highest was found on plot A-3, which was covered with fertile soil and seeded with a mixture of alfalfa and orchard grass. In the following years, the content gradually decreased to 92 ppm (Figure 28). Many of the plots produced crops with too low a content of Mn (16.5 to 50 ppm).

Molybdenum--

Molybdenum is not an essential element for animal life; however, high concentrations of Mo combined with too little amounts of Cu may cause diseases among ruminants. The molybdenum results (Figure 29) showed relatively high concentrations, i.e., from 0.6 to 12.8 ppm. Since amounts of Cu were not satisfactory (Figure 27), supplemental molybdenum may be required.

Zinc--

The optimum content of zinc for plants harvested from grasslands varies from 30 ppm[38] to 80 ppm.[33] Hay gathered in Halemba, particularly from plots covered with fertile soil (Figure 30), contains up to 288 ppm of this microelement (plots C-3, seeded with a mix of alfalfa and orchard grass). Other combinations contained up to 100 ppm of Zn. Assuming that values above 50 ppm are harmful, crops from the following plots should not be used as fodder for animals:

- Blocks A, B, and C covered with fertile soil + NPK (66 to 288 ppm Zn)
- Block D, fertilized with bentonite (51 to 62 ppm Zn)
- Block H, with double mineral fertilization (58.5 to 112 ppm Zn)
- Block O (control) (58.5 to 112 ppm Zn)

Crops gathered in Konin generally show low concentrations of zinc (Figure 30), i.e., from 8.5 to 64 ppm. The majority of samples was close to the lower limit. After choosing the right

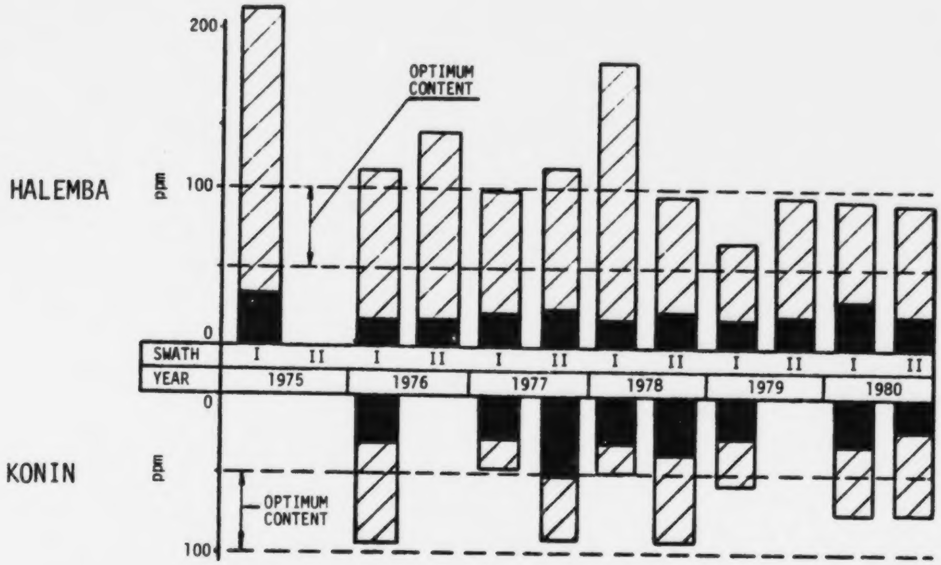


Figure 28. Variations in Mn content of hay from pioneer plants.

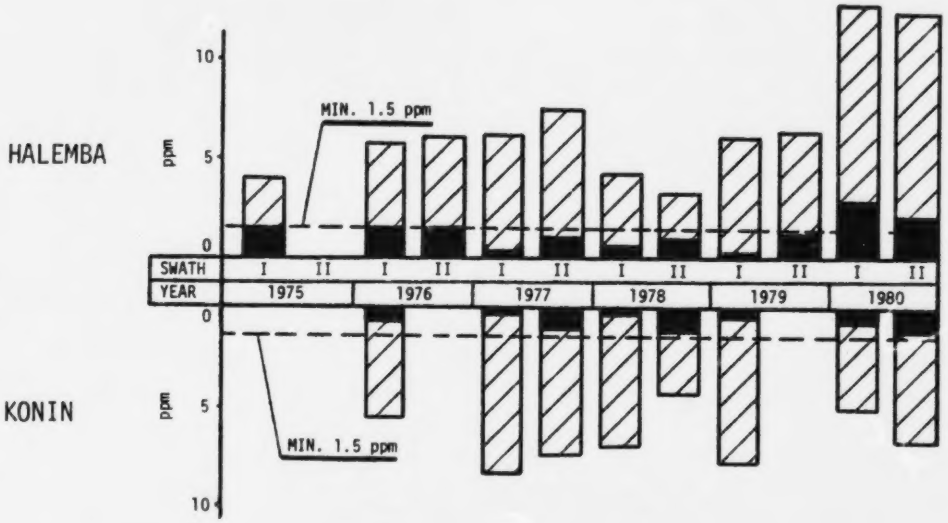


Figure 29. Variations in Mo content of hay from pioneer plants.

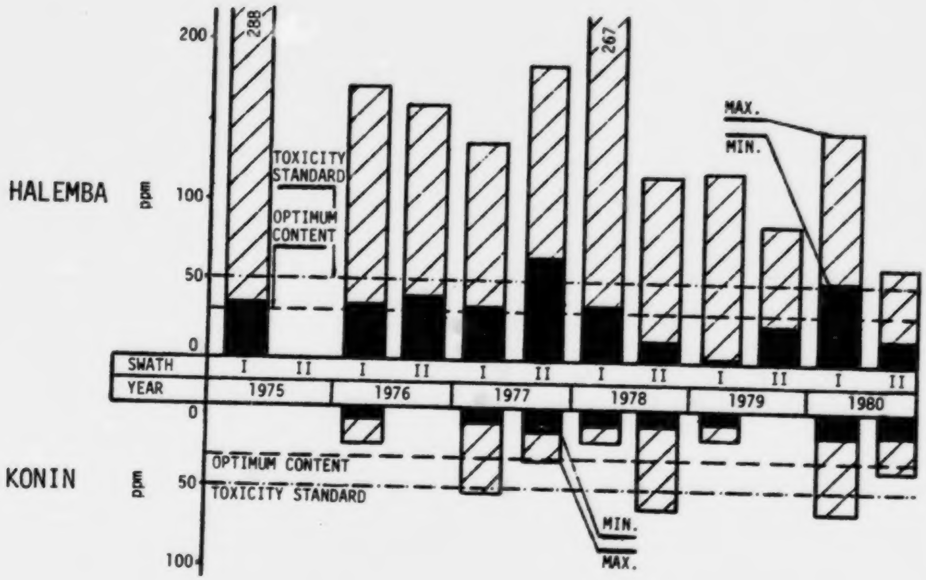


Figure 30. Variations in Zn content of hay from pioneer plants.

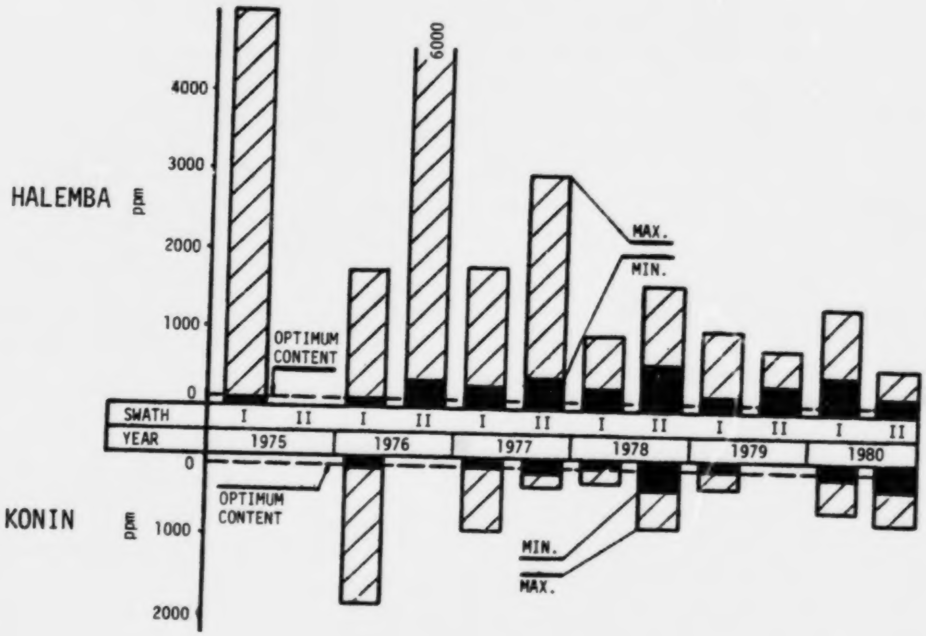


Figure 31. Variations in Fe content of hay from pioneer plants.

method of neutralization and fertilization, the content of Zn in crops should be controlled and corrected using mineral fertilization, if necessary.

Iron--

The content of iron (Figure 31) is frequently many times higher than in plants growing under natural conditions (Tables 17 and 18) and shows intensive absorption of the element from the "ash soil." The highest values of Fe (5000 to 6000 ppm) were found in hay harvested from plot D-2, which was fertilized with bentonite, and from plot F-2, which was fertilized with high moor peat (Halemba).

In Konin, smaller, but still higher, amounts of absorbed iron were found (105 to 1830 ppm). In an alkaline environment, iron may occur in hydroxide form, which is affected by the high pH of ashes. The high content of iron may reduce absorption of other nutritive components. The amount of absorbed iron decreased with time, which indicates its conversion to forms that are hard to dissolve. In the sixth year of cultivation, the iron content in crops decreased from 6000 to 562 ppm. Thus, it is expected that further cultivation will cause successive decrease of the iron reserves.

Cobalt--

Minimum cobalt content in plants harvested from grasslands is 0.05 to 0.1 ppm.[38] The crops contain generally higher amounts of Co, ranging from 0.12 to 1.25 ppm at Halemba and from 0.075 to 0.90 ppm at Konin. (See Figure 32.)

Salinity (Na_2O)--

The average salinity of grasses and legumes (under Polish conditions) is 0.11 percent of Na_2O (Table 19 and Figure 33). Laboratory analyses of hay showed increased salinity in some samples from Halemba and from Konin:

- In Halemba, up to 0.182 percent from control plot 0-3.
- In Konin, up to 0.505 percent from plot C-4 covered with a 5-cm layer of fertile soil.

Higher salinity is found in samples from blocks that are not fertilized with organic matter and soil. The salinity does not tend to decrease with time. It is connected with the high salinity of the formed "ash soils" and with the fallout of alkaline dusts from stacks of the adjacent powerplant.

Radioactivity--

The author's investigation (carried out in years 1975-77)[7] showed that beta activity of hay samples, based on fresh mass, had values below admissible standards (30 pCi/g of fresh mass). The highest beta activity in crops gathered in Halemba was from

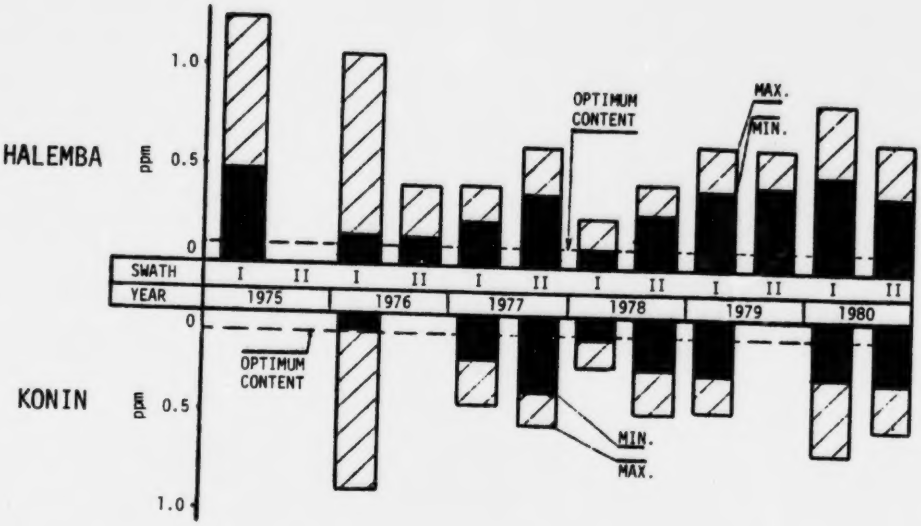


Figure 32. Variations in Co content of hay from pioneer plants.

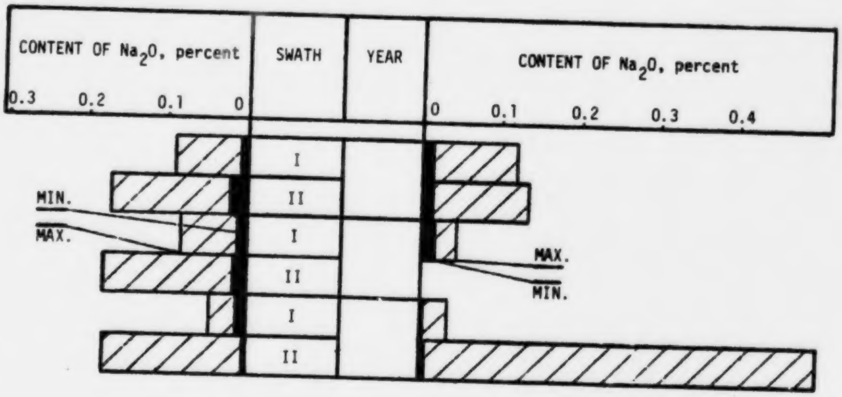


Figure 33. Variations in Na_2O content of hay from pioneer plants.

plots covered with fertile soil and fertilized with farm manure. Beta activity generally comes from the natural isotope ^{40}K. The content of alpha-radiation based on green mass varied from 3.02 to 17.6 pCi/g at Halemba, and from 2.0 to 27.0 pCi/g at Konin.

The values indicate the ability of grass to accumulate radioisotopes. The highest gamma activity, similar to the alpha activity, was observed in crops gathered at Halemba from plots covered with fertile soil and fertilized farm manure. Gamma activity of crops from Konin was lower than the gamma activity of crops from Halemba.

Nutritive Value of Cereals

The quality of barley crops was assessed by analyzing the chemical composition of grain and straw. The data are presented in the Appendix.

Weight of Barley Grains--

The standard weight of 1000 grains of winter barley varies between 36 and 46 g.[39] Grains obtained from the experimental plots were small and only in a few cases equal to the lower limit of the standard values.

Very heavy grains were gathered at Halemba from control plots 0-1, 0-2, and 0-3 where the weights were 40, 37, and 41 g/1000 grains, respectively. These high levels were a result of lower germination, which caused large spacing between plants. On other combinations, the weight of the grains was 24.6 to 40.7 g/1000 grains; the smallest grains were from plot A-2, which was covered with a 20-cm layer of fertile soil and seeded with grasses and legumes as forecrop. The weight of grains from nonfertilized plots (in years 1977-80) was 10 to 15 percent lower than that of grains from fertilized plots. At Konin, the smallest grains were also obtained from plots covered with fertile soil, 24.4 g/1000 grains from plot A-3, on which the forecrop was alfalfa plus orchard grass.

Protein Content--

The average protein content of grains of barley gathered from cultivated soils is 9.4 percent.[39] The protein content of crops gathered at Halemba ranged from 8 percent (plot B-2, covered with a 10-cm layer of fertile soil after cultivation of grasses + legumes mix as forecrop) to 14 percent (plot C-4, covered with a 5-cm layer of fertile soil after cultivation of a mix of alfalfa and orchard grass as a forecrop) to 12.9 percent (plot A-3, covered with a 20-cm layer of fertile soil after cultivation of a mix of alfalfa and orchard grass as a forecrop).

The average protein content of the straw was 5.9 percent at Halemba and 4.0 percent at Konin. The extreme values at Halemba were:

- 9.5 percent in straw from plot C-4, which was covered with a 5-cm layer of fertile soil and had white melilot as a forecrop.
- 2.9 percent in straw from plot B-2, which was covered with a 10-cm layer of fertile soil and grasses and had legumes as a forecrop.

The extreme values at Konin were:

- 5.5 percent in straw from plot C-4 (treated as above).
- 3.1 percent in straw from control plot 0-2, after a forecrop consisting of a mix of grasses and legumes.

Macrocomponents--

The P_2O_5, K_2O, CaO, and K_2O contents of the barley are presented in the appendix. The values were within the limits for average quality barley.

Salinity--

The salinity of the barley ranged from 0.001 to 0.004 percent as Na_2O, and was higher in the grain gathered with plots covered with a layer of fertile soil.

The salinity of straw coming from the same blocks was higher (up to 0.137 percent at Halemba and up to 0.120 percent at Konin). The content of Na_2O in straw from the remaining plots was within the limits of standard values assumed as optimum for hay (0.11 percent).

Microelements--

The standard value of microelements in barley crops gathered from naturally cultivated soils is presented in Table 20. The extreme values of trace elements found in the barley are shown in Table 21. As shown, ashes from Halemba had a higher content of boron (up to 97.5 ppm) and molybdenum. The zinc content also exceeds standard values, which means the ashes may be toxic for people, particularly ashes from plots covered with fertile soil.

Molybdenum also may be toxic if there is a deficiency of copper. The limit for toxicity is the ratio of Cu:Mo = 3.5 to 4.[38] At Halemba, the average ratio of Cu:Mo was 3.8 on plots covered with fertile soil, whereas on control plots the ratio was only 2.2. This indicates that complementary fertilization with Cu is necessary.

At Konin, a higher boron content and a copper deficiency were observed. The ratio of Cu:Mo was 4.9 for plots covered with fertile soil (A, B, C) and 2.7 for control plots. This means that ash soils should be fertilized with copper.

TABLE 20. CONTENT OF MICROELEMENTS IN BARLEY GATHERED FROM CULTIVATED SOILS

Microelement	Fertilization with microelements	Content of microelements, ppm	
		In grain	In straw
B	No	1.4	3.6
	Yes	2.0	4.0
Mn	No	7	20
	Yes	15	35
Cu	No	8	8
	Yes	12	11
Zn	No	40	96
	Yes	48	116
Mo	No	0.8	1.2
	Yes	1.0	3.7

TABLE 21. EXTREME VALUES OF MICROELEMENTS IN BARLEY GRAINS GATHERED FROM EXPERIMENTAL PLOTS (ppm)

Microelement	Extreme value	Disposal site	Plot designation	Ash treatment before seeding forecrop	Mix of forecrop plants
B	4.20	Halemba	A-4	20-cm layer of fertile soil + NPK	White melilot
	1.40	Halemba	E-1	Low moor peat + NPK	Alfalfa
	9.00	Konin	G-2	Farm manure + NPK	Grasses and legumes
	4.60	Konin	A-4	20-cm layer of fertile soil + NPK	White melilot
Mn	20.5	Halemba	A-4	20-cm layer of fertile soil + NPK	White melilot
	9.0	Halemba	E-1	Low moor peat + NPK	All combinations
			F-3	High moor peat + NPK	Alfalfa + orchard grass
			O-1	Control	Alfalfa
	19.0	Konin	F-3	High moor peat + NPK	Alfalfa + orchard grass
	13.5	Konin	D-2	Tertiary sand + NPK	Grasses + legumes
Cu	8.25	Halemba	G-1	Farm manure + MPK	Alfalfa
	3.00	Halemba	B-2	10-cm layer of fertile soil + NPK	Grasses + legumes
	6.50	Konin	A-3	20-cm layer of fertile soil + NPK	Alfalfa + orchard grass
	3.00	Konin	D-1	Tertiary sand + NPK	Alfalfa
			H-1	N_2PK	Alfalfa
			I	NPK	Alfalfa
Zn	97.5	Halemba	A-4	20-cm layer of fertile soil + NPK	White melilot
	26.5	Halemba	O-2	Control without fertilization	Grasses + legumes
	35.0	Konin	D-2	Tertiary sand + NPK	Grasses + legumes
	20.0	Konin	C-2	5-cm layer of fertile soil + NPK	Grasses + legumes
Mo	2.40	Halemba	C-4	5-cm layer of fertile soil + NPK	White melilot
	0.43	Halemba	A-4	20-cm layer of fertile soil + NPK	White melilot
	1.60	Konin	H-1	N_2PK + green manure	Holy clover + crown vetch
	0.46	Konin	A-4	20-cm layer of fertile soil + NPK	White melilot

It was concluded that most of the winter barley can be used by people and animals in mixtures with grains gathered from naturally cultivated soils. Some combinations cannot be used, however, because their Zn content is too high. It was further concluded that a deficiency of copper exists, and that copper should thus be included in the fertilization program.

ASSESSMENT OF TREE AND SHRUB GROWTH

The success of tree and shrub cultures was assessed on the basis of 7 years of field experiments. Health and losses were observed and increments in height of growth were measured every year.

Losses

Detailed results of the observations are presented in the appendix. In general, the reactions of trees and shrubs to toxic ashes differed between the Halemba and Konin sites.

Halemba--

The greatest loss of plants in the first year was observed among birch cuttings. Only one tree survived of the 96 cuttings planted in 1975. Several losses were also observed in 1977 among trees planted for the second time in 1976. Of a total of 191 cuttings planted, only 19 trees survived until 1981, which is less than 10 percent survival.

Larch trees were also difficult to introduce. Only 60 trees of a total of 226 survived, or 26.5 percent.

Figures 34 and 35 present a comparison of survival based on the pit dressing method and on the species of tree and shrub introduced.

These results led to the following conclusions:

- Losses of cuttings did not differ much with method of pit dressing (43.3 to 50.7 percent). Losses were the lowest where high moor peat and mineral fertilizers had been applied.

- Losses of cuttings varied greatly with plant species; e.g., 23.6 percent for locust trees versus 90.0 percent for birch.

Konin--

Trees and shrubs planted in 1975 on calcium-sulphate ashes produced from lignite burned at the Konin powerplant died out completely because of drought and toxic soil conditions. Planted

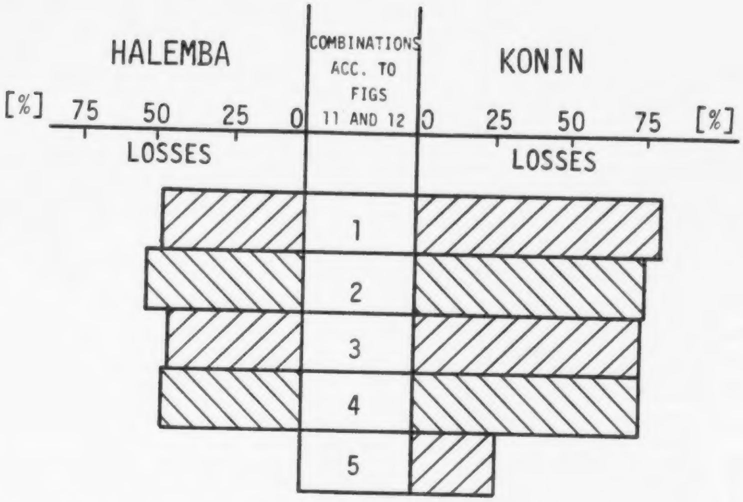


Figure 34. Losses of cuttings with different pit dressing methods.

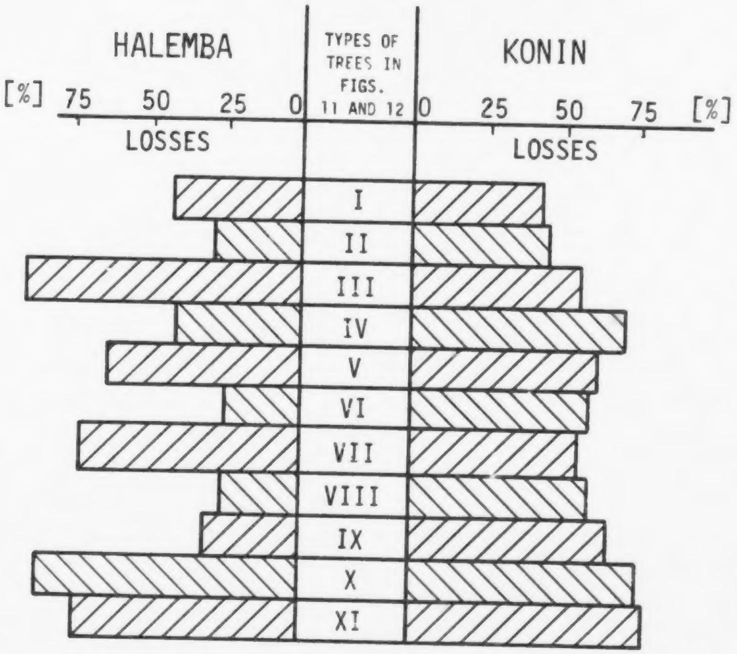


Figure 35. Losses of cuttings with different plant species.

again in 1976, the trees and shrubs with the smallest number of losses (26.6 percent) were planted in pits that had been dressed with fertile soil and mineral fertilizers (Figure 34). On the remaining combinations, losses ranged from 74.6 to 80.1 percent. The highest losses were observed where pits had been dressed with a mix of ash-fertile soil and mineral fertilizers (Figure 34).

Larch trees had very poor results. All trees planted in 1976 died, and those planted again in 1977 suffered considerable losses (the highest in 1980). The trees were weak, and the needles were yellow. Only 43 of the 200 cuttings planted survived until 1981. Poplars had the lowest number of losses (after the second planting in 1976). Those planted in pits dressed with fertile soil had 100 percent survival.

Increments

Assessments of tree and shrub growth increments were based on measurements taken each year. Assessment of the growth increments proved to be difficult for plants that dried from the top and then had side offshoots. For the final assessment, it was assumed that the initial height was at the level of the offshoot. Thus, increments reported every year in interim reports differ from the data presented in the Appendix.

Halemba--

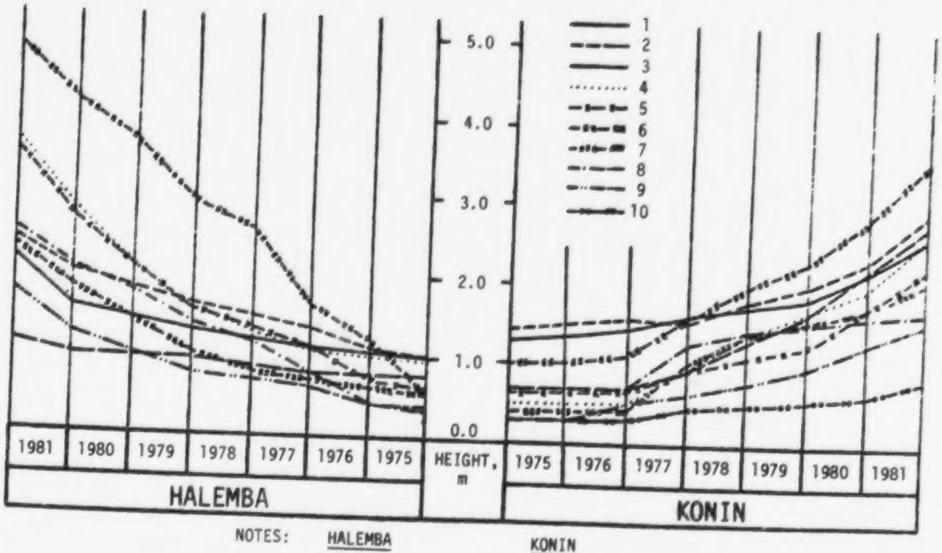
The average growth increment for the period 1975-81 was 234 cm. The highest increments (247 cm) occurred in trees and shrubs planted in pits dressed with peat and mineral fertilizers (247 cm). The lowest (220 cm) were obtained from plantings in pits dressed with bentonite and mineral fertilizers.

A comparison of individual tree and shrub species (Figure 36) showed the highest annual increments to be in locust trees (in the years 1975-1981 (429 cm). Alders also showed great growth dynamics (267 and 306-cm increments) for 1975-1981. At the beginning, larch trees grew rather slowly, but from 1979 on, the annual increments varied from 30 to 55 cm, and the average height after 7 years was 241 cm. Growth of poplars was unsatisfactory. Their initial height was greater than other trees; however, after 7 years, they were outgrown by almost all the other trees and shrubs (Figure 36). Under natural conditions, poplars in Poland reach the height of 9 to 11 m after 7 years.

The average height of trees and shrubs in years 1975-1981 was 234 cm, 43 percent higher than at Konin. This would indicate more favorable vegetation conditions at Halemba on ashes produced from bituminous coal.

Konin--

At Konin the effect of the pit dressing method was more apparent (Figure 37). The greatest growth increments, as was



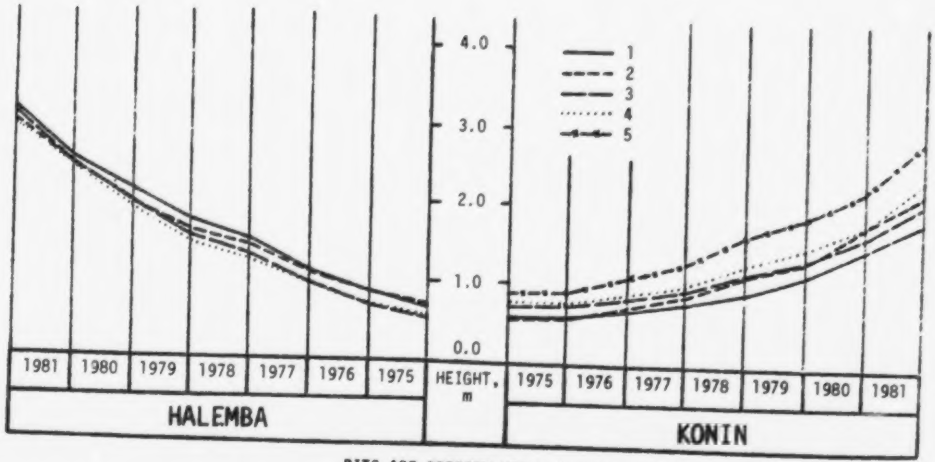
NOTES: HALEMBA

1 - POPLAR 1
2 - POPLAR 2
3 - BIRCH
4 - GRAY ALDER
5 - BLACK ALDER
6 - LOCUST TREE
7 - LARCH TREE
8 - WILLOW
9 - PEA SHRUB

KONIN

1 - POPLAR 1
2 - POPLAR 2
3 - BIRCH
4 - GRAY ALDER
5 - BLACK ALDER
6 - LOCUST TREE
7 - WILLOW
8 - SEA BUCKTHORN
9 - PEA SHRUB
10 - LARCH TREE

Figure 36. Growth of trees and shrubs in years 1975-81.



PITS ARE DRESSED WITH: 1 - ASH + FERTILE SOIL + NP
2 - ASH + BENTONITE (HALEMBA) + NP
3 - ASH + PEAT + NP
4 - ASH + NP
5 - FERTILE SOIL

Figure 37. Growth of trees and shrubs depending on the method of pit dressing before planting.

expected, were observed in plantings in pits dressed with fertile soil and mineral fertilizers (203 cm for the period 1976-1981). Pits dressed with a mixture of ash and fertile soil and mineral fertilizers gave the poorest results (136 cm), which is difficult to explain.

Comparison of heights of particular species of trees and shrubs (Figure 36) indicates high locust tree growth (average of 265 cm over 1976-1981). The larch tree showed the worst growth; these grew less than 10 cm per year and turned yellow and died. Birch grew very well (contrary to Halemba). Their annual increments increased from 26 to 64 cm, and for the 1976-81 period, the average increment for this species was 213 cm. Poplars grew relatively slowly; their average increment in the period was 144 cm, which is only higher than sea buckthorn (101 cm) and larch (45 cm).

Health

Apart from the general macroscopic assessment of tree and shrub health, locust tree leaves were taken every year for laboratory analyses. Leaves of other species could not be taken as their number was too small (particularly in the first year's vegetation) to obtain satisfactory amounts of dry mass for analysis.

Halemba--

Both the survival rate and growth were impacted by microclimatic conditions (droughts), air pollution, and diseases. About 90 percent of the trees had frost-ribs, which were caused by freezing. This occurred more frequently for trees grown on the ashes than for those grown on native soils. The direct negative effect of industrial gas emissions (F_2 and SO_2) was observed for birch and gray alder. Numerous leaf beetles were found on birches. Alders were damaged by Cimbex sp., which caused the death of several trees. Fungi, which were very numerous, contributed to the dying out of cuttings. Locust trees were attacked by the following kinds: Nectria cinnabarina and N. dittisima. In natural forests these are saprophyte fungi, but here they existed as individuals. Willows were attacked by Cryptodiaporthe salicina, which caused bark gangrene and decay of offshoots. In early Autumn, typical symptoms of damage by SO_2 as well as many fungus types concomitant with abiotic damages were observed on alder leaves. The survival rate of cuttings in early years was negatively affected by rabbits, which damaged tree bark in spite of protecting foil and wire net dug into the ground and enclosing the experimental field.

A decrease in some macroelements in locust tree leaves was noted. (See data in Appendix.) Nitrogen decreased from an average of 3.90 percent in 1977 to 3.09 percent in 1981; P_2O_5, from 0.66 to 0.48 percent; and K_2O from 1.80 to 1.18 percent. At the same time, CaO and MgO increased slightly (from 3.31 to 3.44 percent). Similar changes were observed among microelements. As the trees became older, absorption of manganese decreased from 30 ppm in 1977 to 22 ppm in 1981; molybdenum, from 3.7 to 3.4 ppm; zinc, from 81 to 46 ppm; and iron, from 497 to 222 ppm. There was an increase of cobalt absorption from 0.42 to 0.50 ppm.

The method of pit dressing had no important effect on the content of the above elements in tree leaves.

The decrease in the leaves' absorption of nutritive components resulted primarily from the gradual impoverishment of the soil environment in the immediate vicinity of roots. The environment was fed with organic substances (block I and III) and mineral fertilizers (P_2O_5 and K_2O) during planting. When the trees were dug out, it was found that only a few roots exceeded the limits of the pits dug in 1975. This was due to the toxic environment of ash and the physical hindering of root penetration. In addition, alkaline soil (pH 8.5 to 12.8) reduced the absorption of many elements.

All of these factors indicate that introduction of trees and shrubs (particularly useful species) onto ash disposal should be regarded as highly questionable. Only a few species (locust tree, larch, and pea shrub) showed satisfactory adaptation in ash soil whose toxic effect was intensified by dusts and gases in the ambient air.

Konin--

In the first year, the trees and shrubs died out almost completely, apparently as a result of low precipitation, drought conditions intensified by the loosening of base during blasting, and the salinity of the ashes. The losses observed in the following years may be due to the highly toxic environment of the "soil," pollution in the atmosphere from toxic dusts and gases, diseases, and abiotic damages. Despite the fact that the area was enclosed with wire net and the trees were wrapped with foil, rabbits and hares gnawed the offshoots of pea shrubs, willows, locust trees, and gray alders, which affected both their survival rate and their growth. A tree that was particularly vulnerable to gnawing was the larch, whose young needles were gnawed extensively.

The direct effect of industrial emissions (F_2 and SO_2) on leaves was also apparent. Damages found on willows were caused by cockchafers (Lamia textor and Cryptorhynchus lapathi. These insects did not cause direct decay of cuttings, but they populated material already dead. No pathogenic fungi, which might affect the decay of cuttings, were found on larch alder, pea shrub, sea buckthorn, or birch.

A decrease of nutritive components in locust tree leaves was found at Konin. The content of nitrogen decreased from 3.00 percent in 1977 to 2.38 percent in 1981; K_2O, from 1.83 to 0.95 percent; and P_2O_5, from 0.61 to 0.31 percent. The content of CaO + MgO remained almost unchanged. Absorption of toxic boron decreased rapidly from 313 ppm in 1977 to 251 ppm, and the absorption of molybdenum decreased from 12.2 to 4.3 ppm. The decrease of iron absorption varied, depending on the pit dressing method used prior to tree planting.

The lowest deficiency of nutritive components was on the block where pits had been dressed with fertile soil and NP.

As at Halemba, root systems of trees were within the pit limits. Penetration of roots to further parts of the disposal site was sporadic (Figure 38). This limited absorption of mineral elements and water from "ash" soil caused the trees to be subject to wind damage. Cultivated plants whose entire root mass were limited to the 20-cm surface layer were affected similarly (Figure 39).

The attempts to introduce trees and shrubs on calcium-sulphate piles of ash produced by burning lignite presented the same difficulties that would be encountered in forest-type reclamation. Dressing pits with fertile soil decreased the toxicity effects to some extent, and the growth of some pioneer species (birch, gray alder, sea buckthorn) can be regarded as quite good. Sea buckthorn (Hippophae rhamnoides) proved to be particularly successful. This species yielded numerous fruit, many of which produced self-sown plants.

SOIL FORMATION

The properties of aluminum-silicate ashes produced at Halemba and calcium-sulfate ashes produced at Konin have been discussed in detail. Their soil-formation characteristics compared with other ashes were summarized earlier in this report. Fragmentary analyses of changes in the composition and properties of ashes caused by reclamation carried out in the years 1975-1981 are presented here. The course of the soil-formation process was observed indirectly by laboratory analyses of soil samples taken once or twice a year from a depth of 5 to 10 cm or greater, by laboratory analyses of plants collected from experimental plots, and by making balances of nutritive components and toxic substances formed in the soil and in the plants. The analytical results are reported in the Appendix of this report.

Grain-Size Composition of Ash Soils

Grain-size curves of ashes produced at Halemba and at Konin are presented in Figure 40. Pure ashes could be classified as sandy clays, according to the nomenclature used by the U.S.

Figure 38. Konin. Roots of trees after 7 years only in few cases exceed limits of the pit dressed while planting.

Figure 39. Konin. Roots of cultivated plants (melilot) and weeds do not penetrate toxic soil environment.

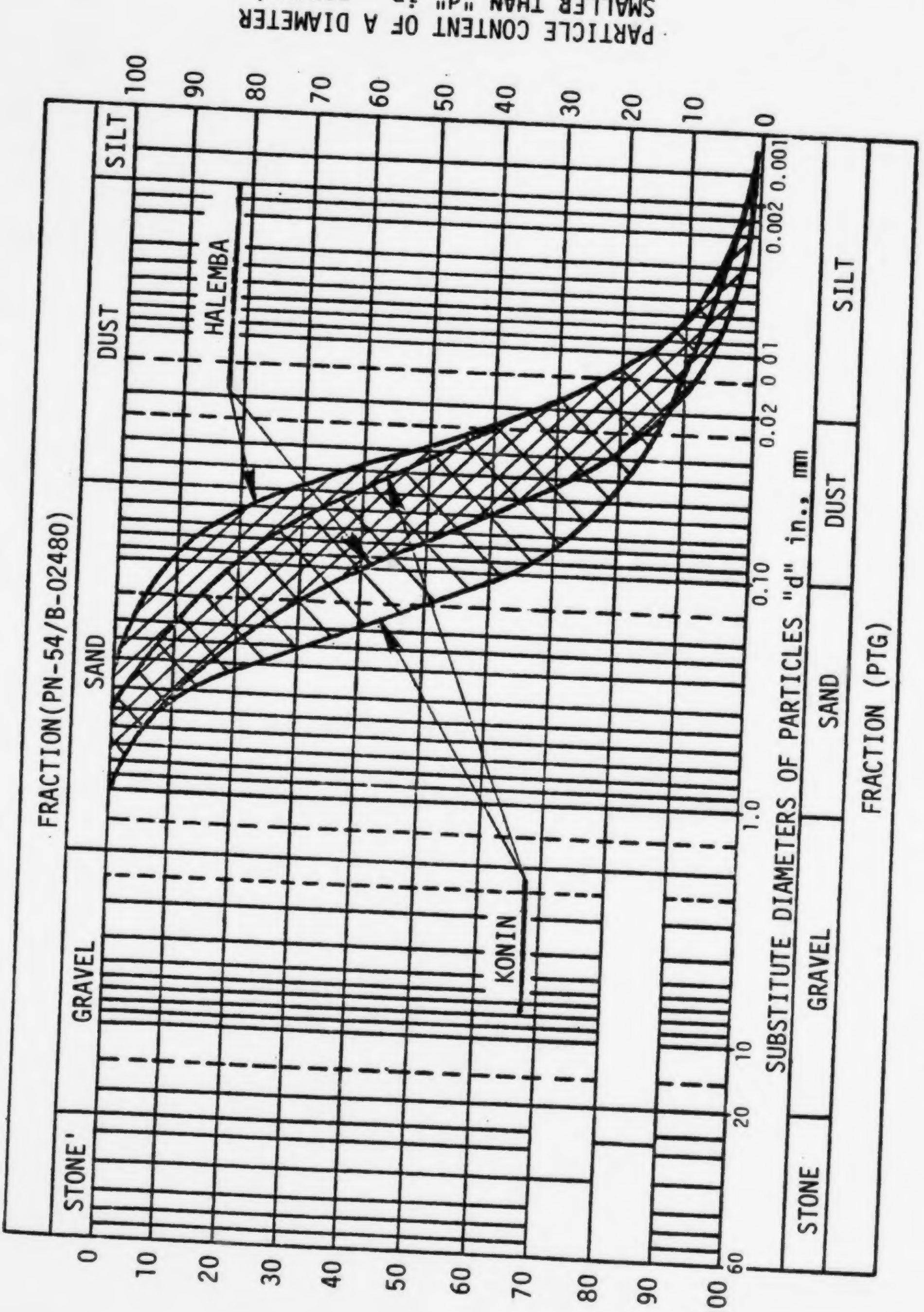


Figure 49. Grain-size composition of amended ashes.

Department of Agriculture (USDA). Grain-size composition of the formed soils changed as a result of the amendments (particularly for those plots covered with fertile soil or additive bentonite and sand). Humus fertile soil and bentonite added at Halemba particularly increased the silty fractions and caused the formed soils to be classified as silty-sandy clays (Figure 41). Adding fertile soil to ashes at Konin caused similar changes in classification. Tertiary sand added to the ashes caused the classification to change towards clayey sands.

Water-Air and Physical Properties of Soils

Water-air properties of the soils formed were very different from those of the raw ash as a result of the discussed changes of grain-size composition, additions of organic substances, mineral fertilization, enrichment in humus and remains of root mass, changes in salinity, and the content of nutritive components.[7]

Ashes in undisturbed samples at Halemba had the following water capacity:

- 19.0 to 20.3 percent (by volume) in blocks A, B, and C, where soil was covered with a fertile soil layer.
- 24.3 to 26.7 percent in blocks E and F, which were fertilized with peat.
- 31.6 percent in block H, which received double N_2PK fertilization.
- 23.0 to 24.8 percent on control block O, which received no fertilization.

Field water capacity in formed soils at Konin were similar.[7]

The color of the formed soils changed because of the increase of organic mass (roots and humus). Gray-blue ashes from Halemba became gray-brown. At Konin they became a light cream color, or almost white. The change of color affects the heating of the soil. With time, they acted similar to that of natural cultivable soils.

The Content of Humus

The change in the humus content of the soils was based on the organic carbon content. The formation of a humus layer in each cultivation block is presented in Figure 42. Generally, soils formed at Halemba had a higher content of organic carbon compared to those at Konin, as a result of the greater mass of the unburned coal in the Halemba ash.

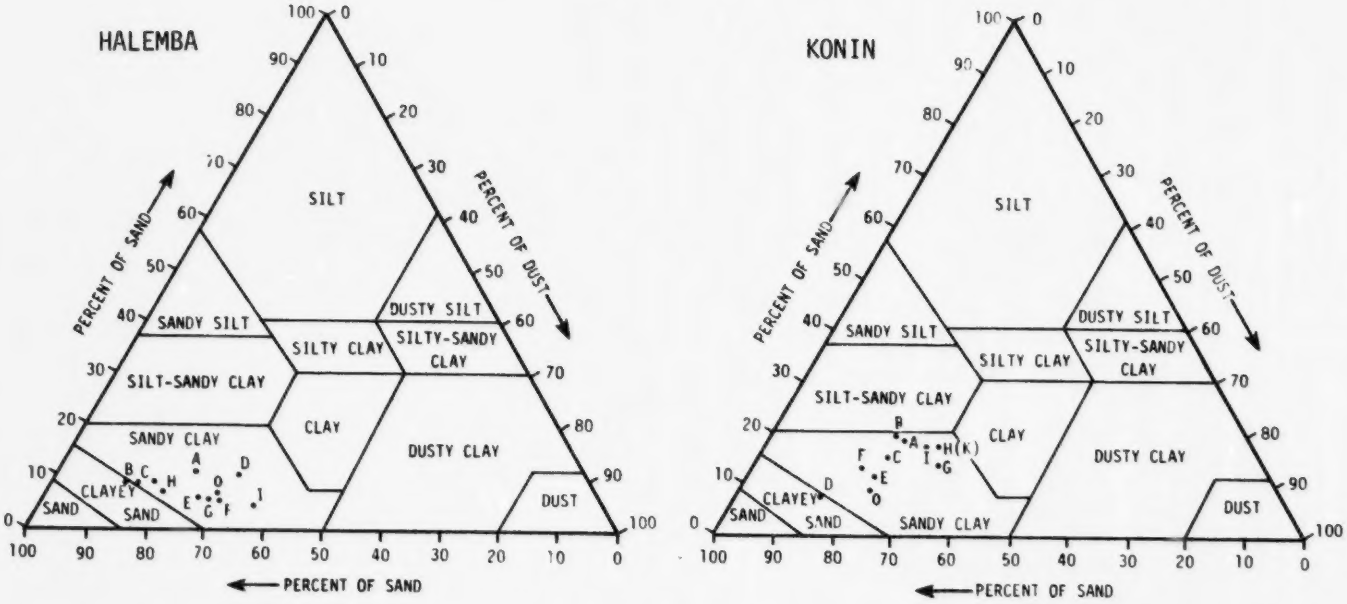


Figure 41. Changes in grain-size composition of ash soils formed after the addition of neutralizing materials.

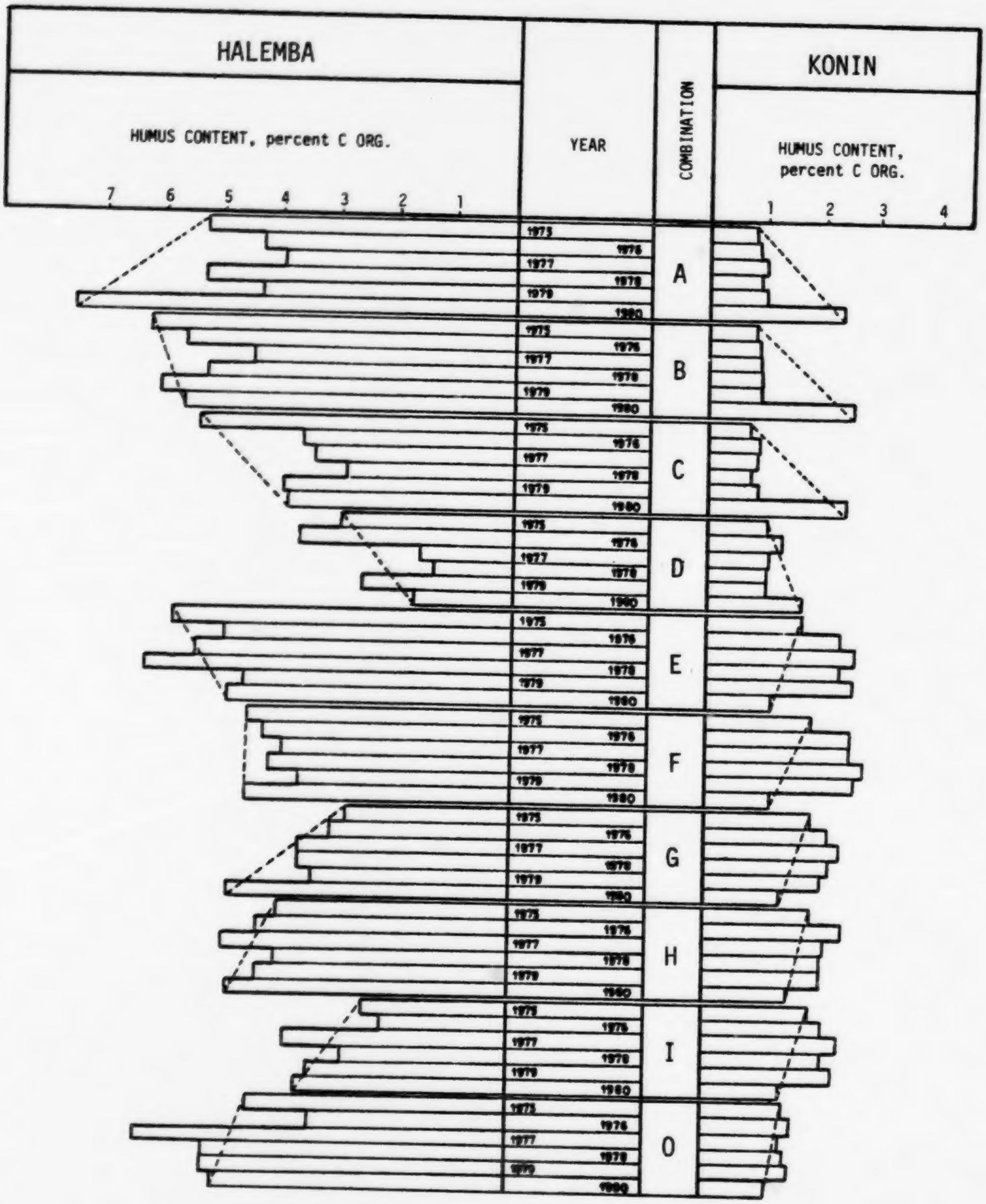


Figure 42. Changes of humus content in formed soils.

Halemba--

On blocks A, B, and C, which were covered with 20-cm, 10-cm, and 5-cm layers of fertile soil, the content of humus systematically decreased as a result of the oxidation of the humus. Similar behavior was observed in the low moor peat in block E. In blocks H and J and control block O, the content of humus systematically increased because of the increase of root mass of cultivated plants and weeds. After 7 years of cultivation, the share of organic parts in the level 5- to 10-cm was almost equal in all cultivated blocks. The exception was block D, where bentonite addition caused the forming of a hard crust at a depth of 10- to 20-cm, which reduced plant growth (penetration of roots and absorption of nutritive components).

Konin--

The soil humus was different at Konin. Blocks A, B, and C were covered with fertile soil doubled in organic carbon content. In the remaining blocks, the organic mass content increased at first, but in the final balance, its value was about 1.5 percent. At deeper layers, less weathered and more toxic material are difficult for roots to penetrate; thus, organic matter content was poor. At a depth of about 20-cm, a layer had formed that was inpenetrable to roots (Figure 39) and impermeable to water; thus, salts washed from the ash soils did not move down into the soil.

The Content of Fundamental Nutritive Components

Halemba--

The P_2O_5 content in formed ash soils (Figure 43) is particularly high on blocks with no fertile soil cover; however, its availability to the plants is doubtful because of the alkaline content of the ash. On blocks A and B, covered with a 10- to 20-cm layer of fertile soil (acidic condition), the P_2O_5 dropped below the desirable value. Variations of the content were caused by mineral fertilization and its absorption by plants. Absorption was the highest on these blocks. (See data in Appendix.)

In the period 1975-1980, the K_2O content dropped significantly on all blocks (Figure 44), below the desirable limit for even poor soils. The K_2O was quickly utilized by plants in the first 2 or 3 years of cultivation, and fertilization with potassium had to be started. Crops grown on blocks A, B, and C (all covered with fertile soil) were also deficient in potassium in the years 1976-1979.

Konin--

Contrary to Halemba, blocks A, B, and C (Figure 43), which were covered with fertile soil, showed good or very good P_2O_5 content (10 to 28 mg of P_2O_5/100 g of soil), and the content was satisfactory on the remaining cultivated blocks. Fertilization with phosphorus, carried on over a few years, systematically increased the content of P_2O_5 in soils.

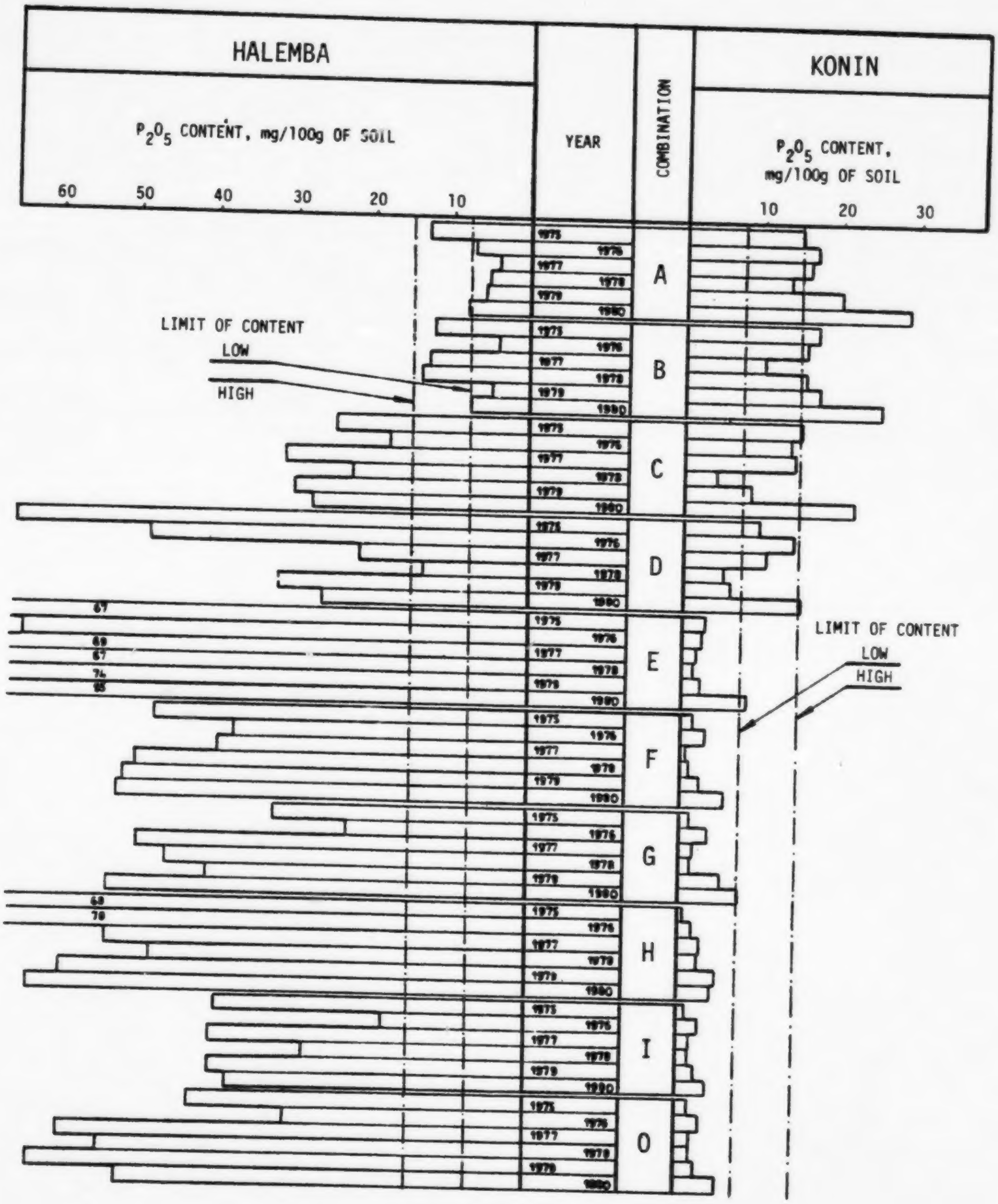


Figure 43. Changes in P_2O_5 content of formed soils.

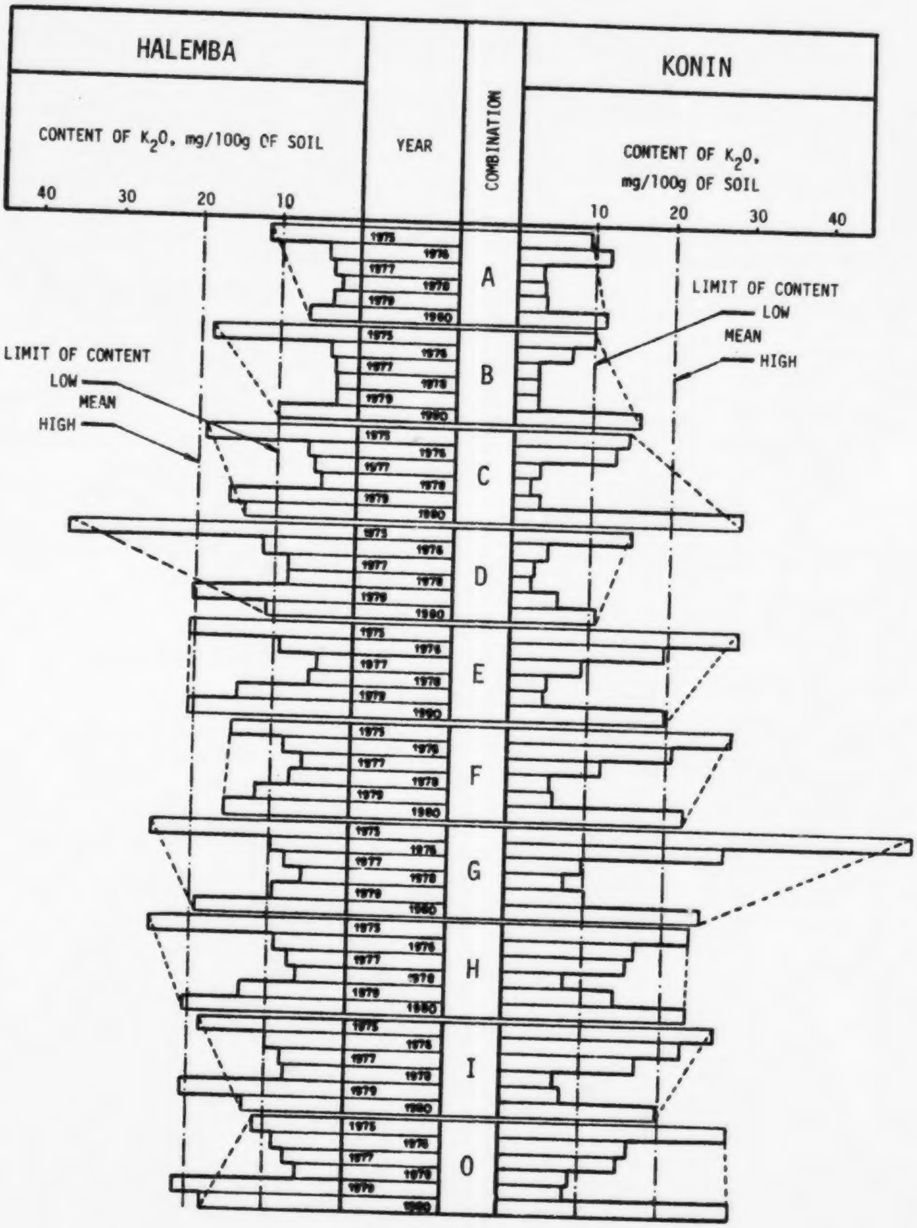


Figure 44. Changes in K_2O content of formed soils.

Potassium trends were similar to those at Halemba (Figure 44); however, washing out and absorption by plants were more intensive because blasting had loosened the soil base to a considerable depth.

In 1977, the K_2O content dropped below the lower limit assumed for natural soils. Fertilizing with potassium in the years 1979-1980 considerably improved the situation, as evidenced by the potassium content of the soil (Figure 44) and the potassium economy balance (Table 16 in Appendix A).

Content of Microelements

The abundance of microelements in ash soils was assessed by comparing the levels with those in natural cultivated soils (Table 22) and against standards used by chemical-agricultural stations in Poland.

TABLE 22. AVERAGE CONTENT OF HEAVY METALS IN NATURAL SOIL (ppm)

Depth	Mn	Zn	Cu	Co	Mo
0-10 cm	359	33	6.4	2.7	0.97
10-20 cm	359	33	6.4	2.7	0.97
25-40 cm	307	24	4.2	3.3	0.91

Boron--

The boron concentration in particular blocks for 1975-1980 is presented in Figure 45.

According to chemical-agricultural stations in Poland, light soils containing more than 0.30 ppm of boron can be regarded as rich in this microelement. The content of boron soluble in water varied at Halemba from 0.3 to 4.7 ppm and averaged 1.4 ppm. In surface layers of soil, the B content is about 0.9 ppm, and it increased to about 3 ppm at a depth of 30 cm. During the 7 years of experiments, no great changes in boron content were observed in the soils formed.

The problem of boron in sulphate-calcium [illegible]es produced by burning lignite at Konin was quite different. [illegible]e content of soluble boron was 40 ppm on a number of plots, i.e., about 130 times more than in natural soils regarded as rich in boron. Vegetation experiments carried out by the author proved that 10 ppm of boron in soil hindered the growth and yields of cultivated plants;[16] whereas, according to Hodgson and Townsend,[15] a concentration exceeding 4 ppm is toxic. In that case, only blocks A

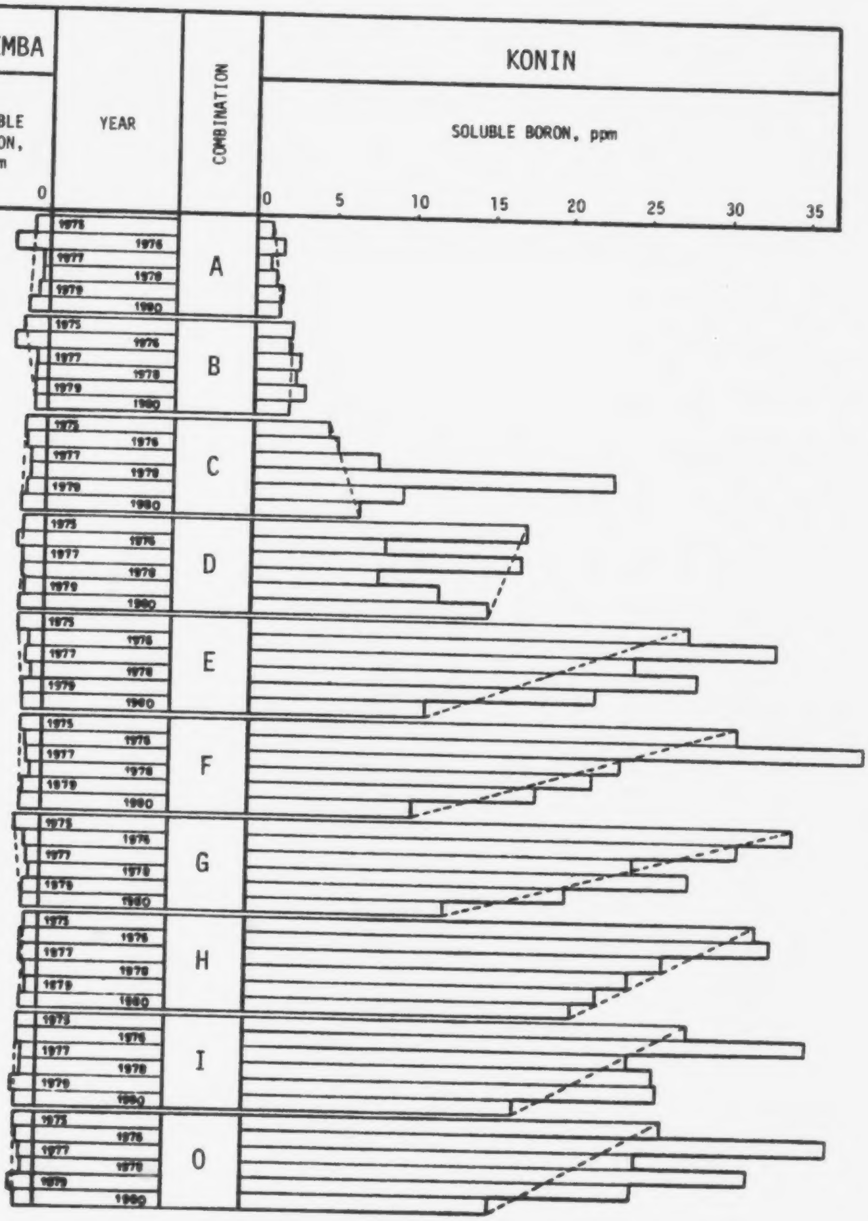


Figure 45. Boron content in formed soils.

and B, covered with a 10- to 20-cm layer of fertile soil, can be regarded as nontoxic to plants (boron content from 0.5 to 7.5 ppm). Deeper layers that came into contact with ashes became toxic, however. At a depth of 30 cm, boron content varied from 5.7 to 30 ppm. As boron moves upward, surface layers also became toxic after some time (Figure 46).

On cultivated blocks which were not fertilized with soil or tertiary sand, the content of boron in surface layers (5- to 10-cm) quickly decreases (from 25-40 ppm to 12-17 ppm) due to absorption by plants and leaching into deeper layers which remain highly toxic.

Manganese--

Ash soils formed in Halemba contain from 0 to 14 ppm of manganese, and soils in Konin contain from 0 to 10 ppm. Even covering with fertile soil and fertilizing with microelements have not improved the situation. In only a few cases, the manganese content increased up to 30 ppm (the required value is at least 70 ppm). Manganese availability is connected with the change of soil pH towards neutrality.

Zinc--

The zinc content of ashes produced at Halemba (0.9 to 39 ppm) is close to the lower limit of the value for natural soils (Table 22). Blocks A, B, and C, however, are very rich in this element (18 to 245 ppm) because the ashes were covered with fertile soil having a high zinc content. Pure ashes should be fertilized with zinc.

At Konin, the zinc content is extremely low (0.0 to 1.0 ppm); it is slightly higher (but not satisfactory) on blocks covered with fertile soil and fertilized with tertiary sand (0.5 to 9.7 ppm).

Copper, Cobalt, Molybdenum--

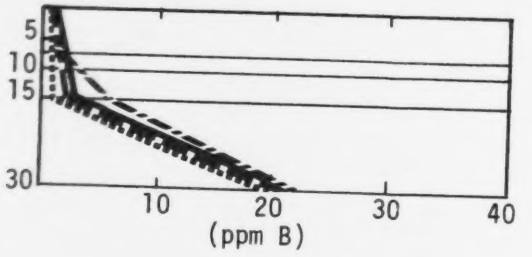
The content of these trace elements in ash soils was determined by analyzing the chemical composition of cultivated plants on particular blocks. Results of these analyses showed:

- A deficiency in copper, except on plots covered with fertile soil, and a positive effect of fertilizing with microelements.

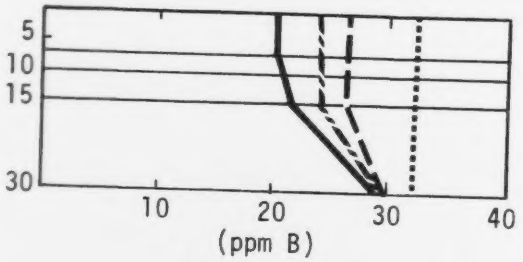
- A satisfactory cobalt content.

- A higher molybdenum content, which when combined with a lack of copper, may cause the crops to be toxic for ruminants.

BLOCK A - ADDITION OF 20 cm OF FERTILE SOIL



BLOCK H(K) - ADDITION OF N2PK + GREEN MANURE



BLOCK O - CONTROL

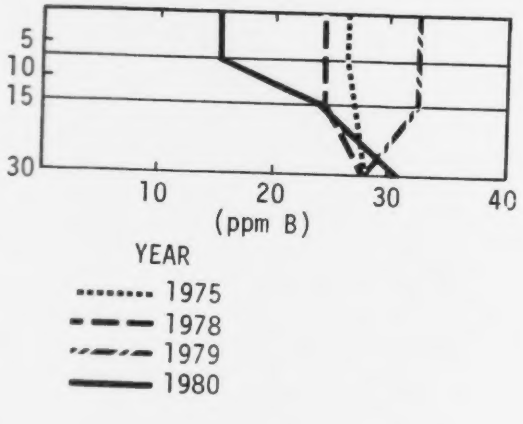


Figure 46. Variations of B content in profiles of formed soils.

pH Results

Changes in pH based on average reaction for four combinations of cultivated plants are presented in Figure 47.

Halemba--

In 1975, the average pH measured on all plots was 7.74; whereas in 1980, it was 7.82, which would indicate that the proposed treatments were not efficient in lowering the pH. This lack of effect was due to the high pH in blocks B and C, which were covered with fertile soil (a 10- and 5-cm layer) and the lowering of pH by 0.2 to 0.6 on the remaining cultivation blocks. This indicates the following:

- Thin layers of fertile soil used to lower the pH of the ashes are not very effective.
- Washing out chlorides and borates and the plants' absorption of these compounds causes gradual pH neutralization.

Konin--

In 1975 the average pH on all plots was 8.44. In 1980 it was 7.87. This appears to be the result of land improvement treatments. Successive pH neutralization is noticeable on all cultivated blocks (Figure 47). It should be emphasized that the neutralization process is observed only in surface layers (to the depth of 20 cm). In deeper layers, the ash remains highly alkaline (pH from 9.0 to 10.7).

Salinity

Salinity was determined by measuring the presence of chlorides. Changes in salinity of the surface soil layer (depth of 5- to 10-cm) on particular cultivation blocks are presented in Figure 48.

Halemba--

The problem of salinity on blocks A, B, and C (each covered with a fertile soil layer) must be discussed separately. In the first year (1975), the salinity on these blocks was relatively high, 0.57 to 1.02 g $NaCl/dm^3$. In the spring and the fall of 1975, salinity decreased to 0.10 to 0.48 g, probably due to biochemical processes occurring in ashes mixed with fertile soil. In the remaining blocks, a large drop in salinity (however, not as great as in the blocks A, B, and C) was also observed in the first year of cultivation. Only on a few combinations did salinity reach values considered toxic for plants. In Poland, the toxicity limit is 1 g $NaCl/dm^3$ of soil.[40] In deeper layers (30-cm), the salinity even increases (maximum 1.86 g/dm^3), which is due to the leaching of salt from overlaying layers.

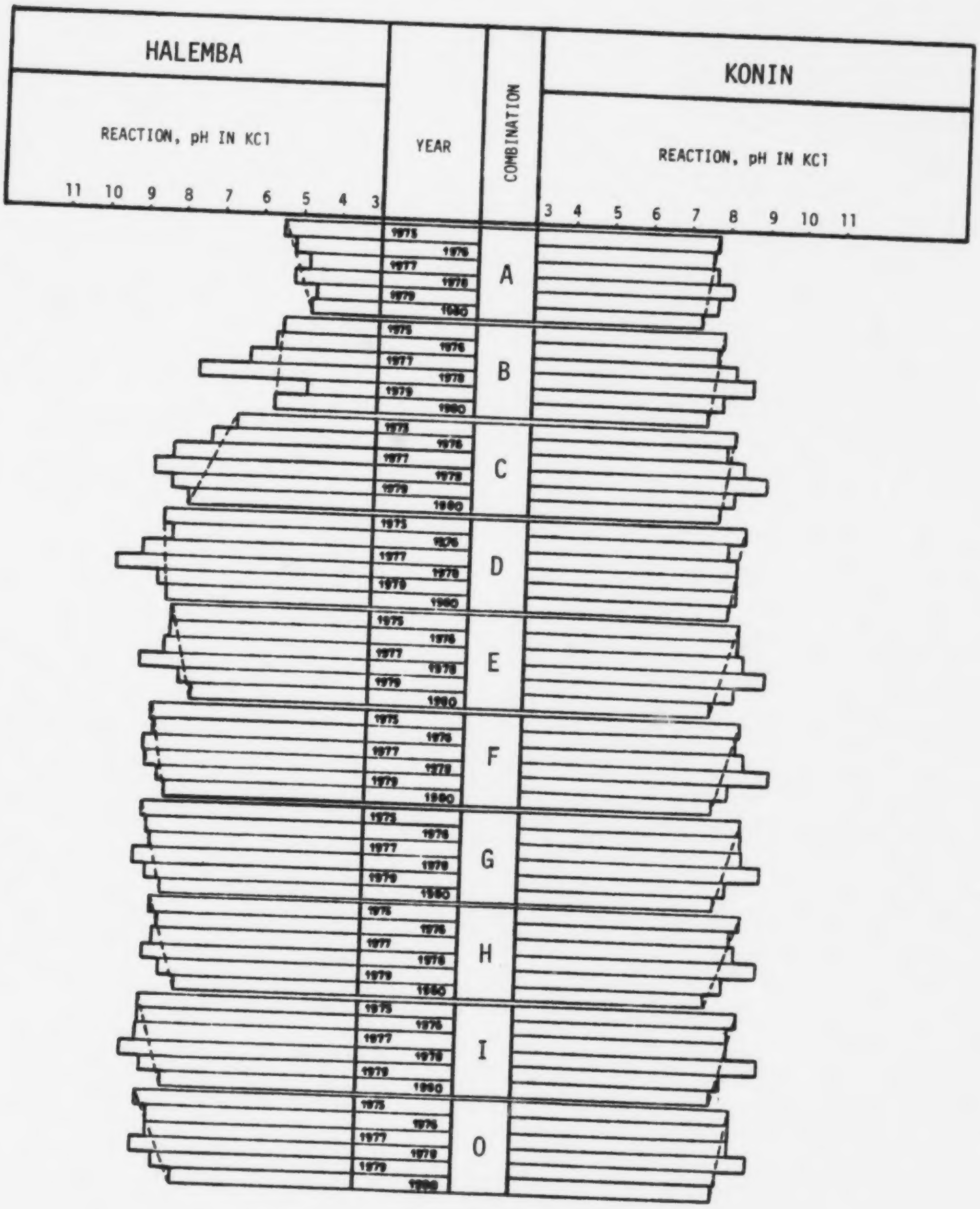


Figure 47. Changes in pH of formed ash soils.

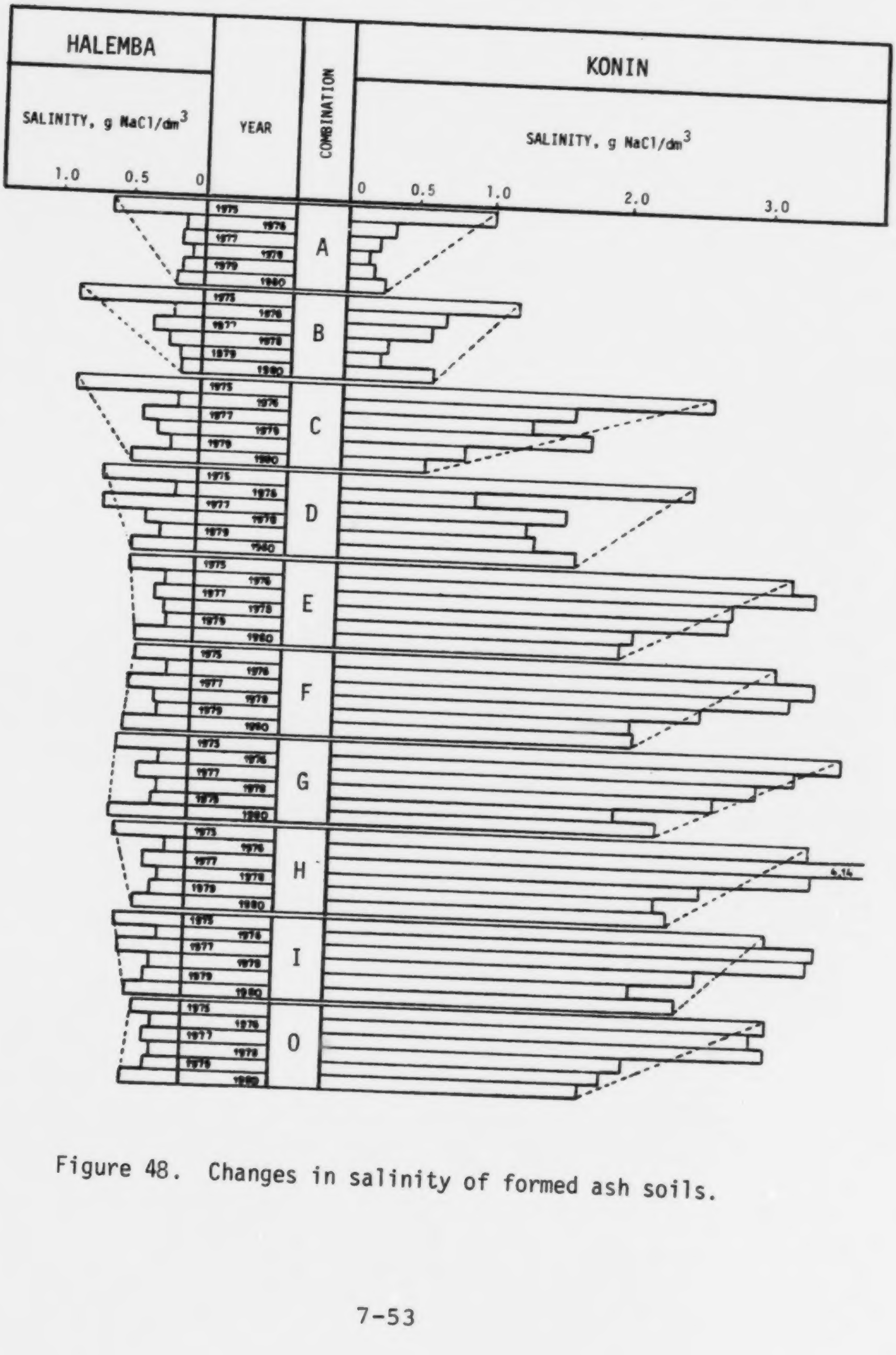


Figure 48. Changes in salinity of formed ash soils.

Konin--

In contrast to Halemba, only a few blocks at Konin (A, B, and C, covered with fertile soil) show salinity below toxic values. In the remaining blocks the initial salinity (spring of 1975) was 1.86 to 3.69 g/dm³; in the summer it increased sporadically as high as 3.87 g/dm³. In the years 1976-1980 it gradually decreased to between 0.85 and 2.82 g/dm³, but only in a limited surface layer. In deeper layers, the salinity remained high (2.10 to 4.05 g/dm³) because of the minimum root penetration, difficulties in leaching, and translocation of the salt from overlaying layers.

Salinity was effectively lowered in the surface root layer only in blocks A, B, and C, which were covered with fertile soil. The salinity of the layer 5- to 10-cm deep was as follows:

- In block A (20 cm of fertile soil) - 0.21 to 0.30 g/dm³
- In block B (10 cm of fertile soil) - 0.36 to 1.02 g/dm³
- In block C (5 cm of fertile soil) - 0.48 to 0.78 g/dm³

At a depth of 30 cm, the salinity was:

- In block A - 0.66 to 1.83 g/dm³
- In block B - 0.75 to 1.53 g/dm³
- In block C - 0.48 to 2.61 g/dm³

SECTION 8

ASSESSMENT OF RESEARCH RESULTS

A statistical analysis was made of the data collected during the study. The statistical approach used is described in Reference 41. The following symbols were used:

Y_{ij} - Yield of jth block (plot) in ith year

$Y_{i\cdot}$ - Sum of y over all blocks for ith year

$Y_{\cdot j}$ - Sum of y over all years for jth block

$Y_{\cdot\cdot}$ - Sum of y over all blocks for all years

F_o - Test function value

n - Quantity of test population

S_{xy} - Covariance

nS_{xy} - Sum of products of x and y deviations from their means

r - Correlation coefficient

$\bar{x}$, $\bar{y}$ - Arithmetic means

S_x - Standard deviation x

S_y - Standard deviation y

t - Student's t-test function value

L - Confidence half-interval

nS_x^2, nS_y^2 - Sum of squares for deviations

V_e - Mean square for error.

c - Number of years

K - Number of plots

YIELD OF PIONEER PLANTS BASED ON THE METHOD OF PLOT TREATMENT

The following combinations of pioneer plants, which were represented in all 10 cultivation blocks, were considered in the statistical analysis: 1) No. 2, a mix of grasses and legumes; and 2) No. 3, a mix of alfalfa and orchard grass.

Halemba - Fertilized Plots

Calculations were made as for blocks completely randomized for n = 6 x 10 observations (Tables 23 and 24).

Calculations for the table (combination 2):

1) $C_y = \frac{Y_{..}^2}{n} = \frac{(296.9)^2}{60} = 1469.1601$

2) $\Sigma Y_{ij}^2 = 2079.7714$

3) $nS_y^2 = \Sigma Y_{ij}^2 - C_y = 610.6113$

4) $nS_{ob}^2 = \frac{\Sigma (Y_{i.})^2}{K} - C_y = 460.983$

5) $nS_{bl}^2 = \frac{\Sigma (Y_{.j})^2}{c} - C_y = 122.6193$

6) $nS_e^2 = nS_y^2 - nS_{ob}^2 - nS_{bl}^2 = 27.009$

7) $V_{ob} = \frac{nS_{ob}^2}{c - 1} = \frac{460.983}{5} = 92.1966$

8) $V_{bl} = \frac{nS_{bl}^2}{K - 1} = \frac{122.6193}{9} = 13.6244$

9) $V_e = \frac{nS_e^2}{(c - 1)(K - 1)} = \frac{27.009}{45} = 0.6002$

TABLE 23. VERIFICATION OF THE HYPOTHESIS F_0 TESTING WHETHER DIFFERENCES IN PIONEER PLANT YIELDS DEPENDING ON THE METHOD OF PLOT TREATMENT IN THE FIRST YEAR OF CULTIVATION ARE SIGNIFICANT

Number of combination	Year	Plot treatment										$Y_{i\cdot}$	$\bar{y}_{i\cdot}$
		A	B	C	D	E	F	G	H	I	0		
2	1975	4.03	2.82	1.54	0.60	1.25	0.12	0.09	0.41	0.39	0.11	11.36	1.14
	1976	6.20	4.56	2.55	1.25	2.13	0.35	0.70	1.96	1.15	2.07	22.92	2.29
	1977	10.82	8.68	8.29	4.76	9.61	5.94	6.18	6.82	5.72	4.51	71.33	7.13
	1978	5.62	4.54	4.31	3.24	3.52	3.47	3.31	4.15	3.39	2.79	38.34	3.83
	1979	9.47	8.46	6.52	4.06	6.02	4.86	5.23	6.71	5.03	6.11	62.47	6.25
	1980	14.00	9.57	9.48	7.50	8.29	7.49	7.97	9.40	7.96	8.82	90.48	9.05
$Y_{\cdot j}$		50.14	38.63	32.69	21.41	30.82	22.23	23.48	29.45	23.64	24.41	296.90	
$\bar{y}_{\cdot j}$		8.356	6.438	5.448	3.568	5.137	3.705	3.913	4.908	3.940	4.068		4.948
$\Sigma_i(X_{ij})^2$		489.0186	287.8565	228.5551	107.8113	215.8064	127.1811	140.5204	201.1287	134.3476	147.5457		
3	1975	2.69	2.12	1.65	1.25	1.29	0.15	0.59	0.77	1.67	1.66	13.84	1.38
	1976	5.12	3.37	3.15	1.58	1.68	0.44	1.54	3.52	1.88	2.98	25.26	2.53
	1977	7.11	6.82	5.69	5.51	6.68	5.70	5.95	5.64	4.97	3.81	57.88	5.79
	1978	3.81	3.33	2.89	2.81	3.58	2.33	2.83	3.86	2.65	2.92	31.01	3.10
	1979	6.85	5.14	4.97	4.24	6.42	4.47	4.01	5.94	4.47	5.97	52.48	5.25
	1980	10.61	7.09	8.05	7.58	9.23	7.90	7.67	7.92	7.88	8.33	82.26	8.23
$Y_{\cdot j}$		36.19	27.87	26.40	22.97	28.88	20.99	22.59	27.65	23.52	25.67	262.73	
$\bar{y}_{\cdot j}$		6.03	4.65	4.40	3.83	4.81	3.50	3.76	4.61	3.92	4.28		4.379
$\Sigma_i(X_{ij})^2$		258.0133	150.1403	142.8766	117.7491	306.0837	120.5259	121.0401	157.7025	120.1220	139.7083		

TABLE 24. VERIFICATION OF THE HYPOTHESIS F_o - CALCULATIONS

Symbol	Calculation	Results	
		Combination 2 (mix of grasses and legumes)	Combination 3 (mix of grasses and legumes)
Cy	$\frac{Y_{..}^2}{n}$	1469.1601	1150.4508
ΣY_{ij}^2		2079.7714	1633.9618
nSy^2	$\Sigma Y_{ij}^2 - Cy$	610.6113	483.511
nS_{ob}^2	$\frac{\Sigma Y_{i.}^2}{K} - Cy$	460.983	315.7681
nS_{bl}^2	$\frac{\Sigma Y_{.j}^2}{c} - Cy$	122.6193	28.3222
nSe^2	$nS_y^2 - nS_{ob}^2 - nS_{bl}^2$	27.009	139.4206
V_{ob}	$\frac{n\,S_{ob}^2}{c - 1}$	92.1966	63.1535
V_{bl}	$\frac{n\,S_{bl}^2}{K - 1}$	13.6244	3.1469
V_e	$\frac{n\,S_e^2}{(c - 1)\,(K - 1)}$	0.6002	3.0982
F_o	$\frac{V_{ob}}{V_e}$	153.6	20.3839
$F_{0.01}$		3.80	3.80
$F_{0.05}$		2.50	2.50

10) $F_o = \frac{V_{ob}}{V_e} = \frac{92.1966}{0.6002} = 153.6$

$F_o > F_{0.01} = 3.80$

$F_o > F_{0.05} = 2.50$

Based on Duncan's test, the following significant differences were found in yields of mixtures of grasses and legumes (combination 2) on particular cultivation blocks, starting with the lowest:

1) Blocks D, F, G, I, O (Yield, 3.57 to 4.07 t/ha)
2) Blocks H, E (Yield, 4.91 to 5.14 t/ha)
3) Block C (Yield, 5.45 t/ha)
4) Block B (Yield, 6.44 t/ha)
5) Block A (Yield, 8.36 t/ha).

The following significant differences in yields, depending on the method of plot treatment prior to cultivation, were found for combination 3 (mix of alfalfa and orchard grass), based on the calculations in Tables 23 and 24:

1) Blocks F, G, D, I (Yield, 3.50 to 3.92 t/ha)
2) Blocks O, C, H, B, E (Yield, 4.28 to 4.81 t/ha)
3) Block A (Yield, 6.03 t/ha).

Halemba - Blocks Not Fertilized in 1977-1980

Pioneer plants on combination 2 (mix of grasses and legumes) are arranged in order by yield (t/ha) starting from the lowest:

O	H	F	E	D	I	G	B	C	A
2.51	2.70	2.74	2.75	2.81	3.01	3.14	3.32	3.43	4.36

Where: $F_o = 14.88 > F_{0.01} = 3.80$

The confidence half-interval was calculated to be:

$L_{0.05} = 1.06$ t/ha

$L_{0.01} = 1.41$ t/ha

Considerable differences were found in yields gathered from particular blocks. Based on Duncan's test, the differences can be arranged in the following order, starting with those with no significant differences and proceeding to those with the most significant differences.

1) O, H, F, E, D, I, G (Yields, 2.51 to 3.14 t/ha) did not have significant differences in yields.

2) B, C, A (3.32 to 4.36 t/ha) did not have significant differences in yields ($p < 0.01$).

Pioneer plants on the combination 3 (mix of alfalfa and orchard grass) are arranged in order by yield starting from the lowest (t/ha).

O	H	E	C	F	B	A	D	I	G
1.96	2.01	2.08	2.31	2.35	2.42	2.59	2.73	2.96	3.25

The confidence half-interval was calculated to be:

$$L_{0.05} = t\left(\frac{Ve}{K}\right)^{\frac{1}{2}} = 1.07 \text{ t/ha}$$

$$F_o = 7.13 > F_{0.01} = 3.80$$

Based on Duncan's test, considerable differences were found in yields of plants from particular blocks:

1) O, H, E, C, F, B, A, D, and I (Yield, 1.90 to 2.96 t/ha)

2) G (Yield 3.25 t/ha)

Differences among yields of the first group were not statistically significant ($p < 0.01$).

Konin - Fertilized Plots

The yields from combination 2 (mix of grasses and legumes) and combination 3 (mix of alfalfa and orchard grass) were considered together, and it was found that the differences in yields of both pioneer plant mixes were not statistically significant ($p >> 0.05$).

Average crop yields from cultivation blocks (t/ha) are arranged in order, starting from the lowest:

O	I	H	F	D	C	E	G	B	A
5.43	6.46	6.89	6.91	7.01	7.23	7.23	7.94	8.58	8.68

where: $F_o = 78.9 > F_{0.05} = 1.99$

$> F_{0.01} = 2.64$

The confidence half-interval was calculated to be:

$L_{0.05} = 1.37$ t/ha

$L_{0.01} = 1.81$ t/ha

Based on Duncan's test, statistically significant differences were found in yields of test plants:

1) Low yields in blocks 0 and I (5.43 to 6.46 t/ha)

2) Average yields in blocks H, F, D, C, and E (6.89 to 7.23 t/ha)

3) High yields in blocks G, B, and A (7.94 to 8.68 t/ha).

Konin - Plots Not Fertilized in Years 1977-1980

Crop yields from combination 2 (mix of grasses and legumes) and combination 3 (mix of alfalfa and orchard grass) were tested together, and it was concluded that the differences in yields of both plant mixes were not statistically significant.

Average crop yields (t/ha) from particular cultivation blocks are arranged in the following order:

O	D	E	I	C	F	H	A	B	G
2.27	2.64	2.96	3.08	3.24	3.28	3.42	3.59	3.89	4.23

where: $F_o = 21.76 > F_{0.05} = 1.99$

$> F_{0.01} = 2.64$

The confidence half-interval was calculated to be:

$L_{0.05} = 1.12$ t/ha

$L_{0.01} = 1.63$ t/ha

Based on Duncan's test, the following groups and subgroups of significance were distinguished in the blocks:

1) Very low crops for block O (2.27 t/ha)
2) Low crops for block D (2.64 t/ha)
3) Average crops for blocks E, I, C, F, H (2.96 to 3.42 t/ha)
4) Moderately high crops for block A (3.59 t/ha)
5) High crops for block B (3.89 t/ha)
6) Highest crops for block G (4.23 t/ha)

DEPENDENCE OF YIELDS UPON PIONEER PLANT SPECIE

Halemba - Fertilized Plots

Calculations are presented in Table 25.

Since $F_o = 1.043 < F_{0.05} = 2.96$

$$< F_{0.01} = 4.60$$

the difference in yields from four combinations of pioneer plants is not considered statistically significant, i.e., independent of the mix used in the experiment.

Halemba - Plots Not Fertilized in Years 1977-1980

Based on data presented in Table 5 of the Appendix, it was calculated that:

$$F_o = 6.1466 > F_{0.05} = 2.96$$

$$> F_{0.01} = 4.60$$

Thus, the differences in yields of pioneer plants cultivated on various combinations should be regarded as statistically significant.

The confidence half-interval was calculated to be:

$$L_{0.05} = 2.138 \text{ t/ha}$$

Based on Duncan's test, the significant differences in yields from the four plant combinations are as follows:

1) Crops of combination 4 (white melilot) are high (21.61 t/ha in years 1975-1980).

TABLE 25. VERIFICATION OF THE HYPOTHESIS F_0 TESTING WHETHER DIFFERENCES BETWEEN YIELDS FROM PARTICULAR PLANT COMBINATIONS ARE SIGNIFICANT (Halemba Fertilized Plots)

Plot treatment	Alfalfa and melilot	Grasses and legumes	Alfalfa and orchard grass	White melilot	Totals
A	-	50.14	36.19	37.67	124.00
B	-	38.63	27.87	25.01	101.51
C	-	32.69	26.40	27.28	86.37
D	28.35	21.41	22.97	-	72.73
E	38.16	30.82	28.88	-	97.86
F	29.07	22.23	20.99	-	72.29
G	23.72	23.48	22.59	-	69.79
H	28.35	29.45	27.65	-	85.45
I	23.13	23.64	23.52	-	70.29
0	27.01	24.41	25.67	-	77.09
Number of observations n_i	$n_1 = 7$	$n_2 = 10$	$n_3 = 10$	$n_4 = 3$	$n = 30$
Sums Y_i	197.79	296.90	262.73	99.96	857.38
Means $\bar{y}_i$	28.256	29.69	26.273	33.320	28.579
Sums of squares $n_i S_i^2$	147.1732	735.7156	169.9331	58.2602	1111.0821
ΣY_i^2	5735.8709	9550.6766	7072.6383	3388.9274	25748.112
$\frac{Y_i^2}{n_i}$	5588.6977	8814.9610	6902.7052	3330.6672	24637.03

1) $C_y = \frac{Y^2}{n} = \frac{(857.38)^2}{30} = 24503.348$

2) $\Sigma Y^2 = 25748.112$

3) $nS_y^2 = \Sigma Y^2 - C_y = 25748.112 - 24503.348 = 1244.764$

4) $nS_{ob}^2 = \Sigma\left(\frac{Y_i^2}{n_i}\right) - C_y = 24637.03 - 24503.348 = 133.682$

5) $nS_e^2 = nS_y^2 - nS_{ob}^2 = 1244.764 - 133.682 = 1111.082$

6) $V_{ob} = \frac{nS_{ob}^2}{3} = \frac{133.682}{3} = 44.561$

7) $V_e = \frac{nS_e^2}{26} = \frac{1111.082}{26} = 42.734$

8) $F_0 = \frac{V_{ob}}{V_e} = \frac{44.561}{42.734} = 1.043$

2) Crops of combinations 1 (alfalfa and melilot) and 2 (grasses and legumes) are average (19.24 and 18.42 t/ha, respectively, in the years 1975-1980).

3) Crops of combination 3 (alfalfa and orchard grass) are the lowest (14.84 t/ha in the same period).

Konin - Fertilized Plots

As at Halemba, it has been found that:

$$F_o = 13.775 > F_{0.05} = 2.96$$

$$> F_{0.01} = 4.60$$

Thus, the combination of plants used significantly influences yields from particular cultivation blocks.

The confidence half-interval was calculated to be:

$$L_{0.05} = 3.73 \text{ t/ha}$$

$$L_{0.01} = 4.05 \text{ t/ha}$$

Based on Duncan's test, it was found that the yields obtained from combination 3 (alfalfa and orchard grass) were statistically significantly higher (total 19.46 t/ha in the years 1975-1980). On the remaining combinations, differences in yields (combination 1, 10.09 t/ha; combination 2, 13.21 t/ha; combination 4, 11.94 t/ha; total in years 1975-1980) did not depend on the seed mix planted.

Konin - Plots Not Fertilized in Years 1977-1980

Calculations for four combinations of plant mixtures cultivated on experimental plots in 10 blocks (A through O) showed the following:

$$F_o = 17.515 > F_{0.05} = 2.98$$

$$> F_{0.01} = 4.64$$

Thus, the plant mixture has a statistically significant influence on yield under the experimental conditions that existed during this study. The standard deviation is 2.824

The confidence half-interval was calculated to be:

$$L_{0.05} = 3.73 \text{ t/ha}$$

$$L_{0.01} = 4.05 \text{ t/ha}$$

Duncan's test showed statistically significant differences in yields of the following groups:

1) Combination 3 - Higher yields for the mixture of alfalfa and orchard grass (total 19.46 t/ha in years 1975-1980)

2) Remaining combinations (Nos. 1, 2, and 4) - Differences in yields were not statistically significant (10.09 t/ha, 13.21 t/ha, and 11.94 t/ha, respectively, in years 1975-1980).

YIELDS OF BARLEY (GRAIN)

Data in Table 25 of the Appendix were used to test the hypothesis F_o regarding the effect of the type of forecrop plants and the method of plot treatment in 1975 on the yield of winter barley in 1981 (Table 26).

The calculated value of

$$F_o = 0.3392 < F_{0.05} = 2.98$$

confirms that there are no statistically significant differences in yields dependent on the kind of forecrop plants.

The calculated value of

$$F_o = 4.394 > F_{0.05} = 2.96$$
$$< F_{0.01} = 4.60$$

indicates that there are significant differences ($0.01 < P < 0.05$) in yields depending on the method of plot treatment.

Duncan's test indicated statistically significant differences between the following blocks:

1) The lowest yields were on blocks F, C, and D (1.16, 1.49, and 1.49 t/ha, respectively).

2) Yields were average on blocks G and I (1.90 and 2.15 t/ha, respectively.

TABLE 26. VERIFICATION OF THE HYPOTHESIS F_o ABOUT THE SIGNIFICANCE OF THE EFFECT OF PLOTS AND PIONEER PLANT TREATMENT METHODS ON WINTER BARLEY (GRAIN) YIELDS (HALEMBA FERTILIZED PLOTS)

Plot treatment	Mixture of alfalfa and melilot, t/ha	Mixture of grasses and legumes, t/ha	Mixture of alfalfa and orchard grass, t/ha	White melilot, t/ha	$Y_{\cdot j}$	$\bar{y}_{\cdot j}$	ΣY_j^2	$\frac{Y_{\cdot j}^2}{n_j}$
A	-	4.230	3.900	2.050	10.18	3.393	37.3054	34.5441
B	-	2.500	2.710	3.000	8.21	2.736	22.5941	22.4680
C	-	2.530	1.160	0.780	4.47	1.490	8.3549	6.6603
D	1.210	1.500	1.760	-	4.47	1.490	6.8117	6.6603
E	3.330	2.840	2.020	-	8.19	2.730	23.2349	22.3587
F	1.250	0.850	1.380	-	3.48	1.160	4.1894	4.0368
G	1.410	2.040	2.240	-	5.69	1.897	11.1673	10.7920
H	2.600	2.430	2.170	-	7.20	2.400	17.3738	17.2800
I	2.190	2.310	1.940	-	6.44	2.147	13.8958	13.8245
O	2.050	2.410	2.480	-	6.94	2.313	16.1610	16.0545
n_i	$n_1 = 7$	$n_2 = 10$	$n_3 = 10$	$n_4 = 3$	$n = 30$			
$Y_{i\cdot}$	14.040	23.640	21.760	5.830	65.270		161.0883	154.6792
$\bar{y}_{i\cdot}$	2.006	2.364	2.176	1.943				
ΣY_i^2	31.8622	62.7926	52.6226	13.8109				161.0883
$\frac{Y_{i\cdot}^2}{n_i}$	28.1602	55.8850	47.3498	11.3296				142.7246

Forecrop plants

1) $C_y = \frac{Y_{..}^2}{n} = (\frac{65.27}{30}) = 142.0058$

2) $Y_{..} = 65.27$

3) $\Sigma Y^2 = 161.0883$

4) $nS_y^2 = \Sigma Y^2 - C_y = 161.0883 - 142.0058 = 19.0825$

5) $nS_{ob}^2 = \Sigma\left(\frac{Y_i}{n_i}\right)^2 - C_y = 142.7246 - 142.0058 = 0.7188$

6) $nS_e^2 = nS_y^2 - nS_{ob}^2 = 19.0825 - 0.7188 = 18.3637$

7) $V_{ob} = \frac{nS_{ob}^2}{3} = \frac{0.7188}{3} = 0.2396$

8) $V_e = \frac{nS_e^2}{26} = \frac{18.3637}{26} = 0.7063$

9) $F_o = \frac{V_{ob}}{V_e} - \frac{0.2396}{0.7063} = 0.3392$

Plot treatments

1) $C_y = \frac{Y^2}{n} = (\frac{65.27}{30})^2 = 142.0058$

2) $Y_{..} = 65.27$

3) $\Sigma Y^2 = 161.0883$

4) $nS_y^2 = \Sigma Y^2 - C_y = 161.0883 - 142.0058 = 19.0825$

5) $nS_{bl}^2 = \Sigma\left(\frac{Y_{\cdot 1}}{n_j}\right)^2 - C_y = 154.6792 - 142.0086 = 12.6734$

6) $nS_e^2 = nS_y^2 - nS_{bl}^2 = 19.0825 - 12.6734 = 6.4091$

7) $V_{bl} = \frac{nS_{bl}^2}{9} = \frac{12.6734}{9} = 1.4082$

8) $V_e = \frac{nS_e^2}{20} = \frac{6.4091}{20} = 0.3205$

9) $F_o = \frac{V_{bl}}{V_e} = \frac{1.4082}{0.3705} = 4.394$

3) Yields were higher on blocks O, H, E, and B (2.31, 2.40, 2.73 and 2.74 t/ha, respectively.

4) Yields were highest on block A (3.39 t/ha).

Konin - Fertilized Plots

The statistical significance test indicates that neither the method of plot treatment nor the composition of the forecrop plant mixture affects barley yields as evidenced by the low F ratios:

$$F_o = 0.589 < F_{0.05} = 2.96$$

$$F_o = 0.927 < F_{0.05} = 2.96$$

GROWTH OF TREES AND SHRUBS

Dependence of Growth Increments on Method of Pit Dressing Prior to Planting

Halemba--

Annual increments of growth for trees and shrubs (1975-1981) and weighted means of these increments are presented in Table 37 of the Appendix.

Results of a test carried out to determine the relationship between tree growth increments and the method of pit dressing prior to planting (1975) are shown in Table 27. Based on these results:

$$F_o = 1.0025 < F_{0.05} = 2.82$$

Thus, there is no statistically significant relationship between tree and shrub growth and the method of pit dressing at Halemba.

Konin--

A significance test was based on data from Table 38 in the appendix. Calculations indicate that:

$$F_o = 1.484 < F_{0.05} = 2.61$$

Thus, no statistically significant relationship was found between tree and shrub growth increments and pit dressing method.

Dependence of Growth Increments on the Species of Trees and Shrubs

Halemba--

The calculations in Table 28 show:

TABLE 27. ANALYSIS OF AVERAGE INCREMENTS IN HEIGHT OF PARTICULAR PLANT AND SHRUB SPECIES AFTER 7 YEARS OF VEGETATION AT HALEMBA (cm)

Pit dressing combi- nation	Species of trees and shrubs									$Y_{\cdot j}$	$\bar{y}_{\cdot j}$
	I	II	III	IV	V	VI	VII	VIII	IX		
1	222.3	173.0	114.3	277.4	275.3	431.9	124.3	214.2	130.4	1963.1	218.122
2	61.4	158.3	85.6	247.1	259.5	413.3	187.5	233.3	128.6	1774.6	197.178
3	102.0	153.0	110.0	294.5	332.3	413.9	158.4	241.1	172.9	1978.1	219.789
4	143.0	97.3	37.5	266.8	305.9	453.9	177.9	201.1	137.2	1820.6	202.289
$Y_{i\cdot}$	528.7	581.6	347.4	1085.8	1173.0	1713.0	648.1	889.7	569.1	7536.4	
$\bar{y}_{i\cdot}$	132.175	145.15	86.85	271.45	293.25	428.25	162.025	222.425	142.275		209.317
ΣY_i^2	84,040.25	87,664.18	33,898.10	295,921.66	347,128.44	734,692.92	107,345.71	198,880.95	82,260.37	1,971,832.58	

1) $SY^2 = 1,971,832.6$

2) $Y_{\cdot\cdot} = 7535.4$

3) $C_y = \frac{(Y_{\cdot\cdot})^2}{n} = \frac{(7536.4)^2}{36} = 1,577,703.5$

4) $nS_y^2 = \Sigma Y^2 - C_y = 1,971,832.6 - 1,577,703.5 = 394,129.1$

5) $nS_{bl}^2 = \Sigma\left(\frac{Y_{i\cdot}^2}{4}\right) - C_y = \frac{7,763,203.2}{4} - 1,577,703.5 = 363,097.3$

6) $nS_{ob}^2 = \Sigma\left(\frac{Y_{\cdot j}}{9}\right)^2 - C_y = \frac{14,230,430.7}{9} - 1,577,703.5 = 3455.7$

7) $nS_e^2 = nSy^2 - nS_{bl}^2 - nS_{ob}^2 = 394,129.1 - 363,097.3 - 3455.7 = 27,576.1$

8) $V_{ob} = \frac{nS_{ob}^2}{3} = \frac{3455.7}{3} = 1151.9$

9) $V_{bl} = \frac{nS_{bl}^2}{8} = \frac{363,097.3}{8} = 45,387.16$

10) $V_e = \frac{nS_e^2}{24} = \frac{27,576.1}{24} = 1149$

11) $F_o = \frac{V_{bl}}{V_e} = \frac{45,387.16}{1149} = 39.50$

$= 39.5 > F_{0.05} = 2.23$

$> F_{0.01} = 3.07$

12) $F_o = \frac{V_{ob}}{V_e} = \frac{1151.9}{1149} = 1.0025$

$= 1.0025 < F_{0.05} = 2.82$

$< F_{0.01} = 4.26$

$$F_o = 39.50 > F_{0.05} = 2.23$$
$$> F_{0.01} = 3.07$$

Thus, there is a statistical dependence of growth height increments on tree and shrub species.

Based on Duncan's test, increments were arranged as follows:

1) The smallest increments were in birch (III) - 87 cm in years 1975-1981

2) Increments were greater in poplar I(I), willow (IX), poplar II (II), larch (VII) - 132, 142, 145, and 162 cm, respectively

3) Increments were significantly greater in pea shrub (VIII) - 222 cm

4) Increments were greater in alders, gray (IV) and black (V) - 271 and 293 cm, respectively

5) Increments were greatest in locust trees (VI) - 428 cm in years 1975-1981

Konin--

It was calculated that:

$$F_o = 4.433 > F_{0.01} = 2.88$$
$$> F_{0.05} = 2.12$$

This indicates a statisticlaly significant relationship between the highest growth increments and the species of trees and shrubs. Duncan's test was used to arrange growth increments in the following way:

1) The lowest increment in 1975-1981 was in larch (XI) - 37 cm

2) Increments were average in sea buckthorn (VIII), poplar I (I), pea shrub (IX), poplar II (II), aspian willow (VII), and black alder (V) - 100, 129, 130, 151, 158, 159 cm, respectively

3) Increments were highest in gray alder (IV), white birch (III), and locust trees (VI) - 188, 213, and 266, respectively, in years 1975-1981

LOSSES OF TREES AND SHRUBS

Halemba

The significance of differences in tree and shrub losses was tested by using data from Appendix Table 39. It was calculated that:

$$F_o = 0.06 < F_{0.05} = 2.83$$
$$< F_{0.01} = 4.29$$

Thus, there is no apparent relationship between tree and shrub losses and pit dressing.

$$F_o = 10.07 > F_{0.01} = 3.01$$
$$> F_{0.05} = 2.19,$$

There is, however, a statistically significant dependence of losses upon plant species. Duncan's test was used to arrange losses of plants depending on their species:

1) The smallest losses: locust tree (23.6 percent), pea shrub (25.2 percent), poplar II (29.8 percent), willow (30.9 percent in 1975-1981)

2) Small losses: poplar I (41.7 percent) and gray alder (43.0 percent)

3) Average losses: black alder (63.3 percent)

4) Large losses: poplar cuttings (71.8 percent) and larch (73.5 percent)

5) Very large losses: willow cuttings (86.8 percent) and birch (90.1 percent in years 1975-1981)

The confidence half-interval was calculated to be:

$$L = 7.91 \text{ percent}$$

Konin

Data included in Appendix Table 40 were used to perform a statistical significance test for the dependence of losses on the method of pit dressing and on the cutting species.

The Snedecor test for the significance of differences indicates that these losses of trees and shrubs are dependent on the method of pit dressing:

$$F_o = 21.74 > F_{0.05} = 2.56$$
$$> F_{0.01} = 3.72$$

The confidence half-interval was calculated to be:

L = 42.9 percent

Based on Duncan's test, the dependence of losses on the pit dressing method was arranged in the following way:

1) Large losses:

Combination 2 - 68.1 percent

Combination 4 - 68.1 percent

Combination 3 - 69.2 percent

Combination 1 - 71.3 percent

2) Small losses:

Combination 5 (pits dressed with fertile soil and NP) - 21.7 percent

Differences within the first subgroup are statistically insignificant. Based on the results of the Snedecor test, the species of cutting does not influence its losses.

$$F_o = 1.86 < F_{0.05} = 2.05$$
$$< F_{0.01} = 2.75$$

The confidence half-interval was calculated to be:

L = 20.5 percent

This includes all cutting species; losses range from 43.3 percent (poplar I) to 78.5 percent (poplar cuttings) and average 60.0 percent.

DEPENDENCE OF PIONEER PLANT YIELDS ON ATMOSPHERIC CONDITIONS

Dependence of Yields on Air Temperature in Spring-Summer Period

Statistical calculations have been carried out for crops obtained from mixtures No. 2 and No. 3 and for average temperatures for the years 1976-1980.

Halemba--

The calculation for Halemba showed:

- Low negative correlation ($r = -0.138$) between yields and temperature in the spring-summer period for plots fertilized in the years 1975-1980.
- Low positive correlation ($r = + 0.175$) for plots not fertilized in the years 1977-1980.

Konin--

Based on statistical calculations for the period 1976-1980, it has been found that:

- There was a relatively low negative correlation ($r = -0.343$) between the yield of the pioneer plant (mixtures No. 2 and No. 3) and air temperature in the spring-summer period for plots fertilized in years 1975-1980.
- There was no correlation for plots not receiving mineral fertilization in years 1977-1980 ($r = -0.067$).

Dependence of Yields on Precipitation

Calculations were based on total precipitation for the period March through August in the years 1976-1980, and on yields of mixtures No. 2 and No. 3 from all cultivation blocks.

Halemba--

Statistical calculations revealed:

- A low degree of correlation between precipitation and yields for plots fertilized in years 1975-1980 ($r = -0.196$).
- A relatively high correlation between yields and total precipitation ($r = +0.701$) on plots not fertilized in years 1977-1980.

Konin--

A high dependence of pioneer plant yields on total precipitation in spring-summer season was found. Correlation coefficients were:

- $r = +0.988$ for plots fertilized in years 1975-1980.
- $r = +0.792$ for plots not receiving mineral fertilization in years 1977-1980.

DEPENDENCE OF YIELDS ON PH OF THE FORMED ASH SOILS

Halemba - Fertilized Plots

Statistical calculations showed a significant negative correlation between soil reaction and yields of pioneer plants (combinations 2 and 3) on blocks G (fertilization with farm manure), H (double fertilization with N2PK), and O (not fertilized until 1976), where the correlation coefficients were -0.677, -0.711, and -0.917, respectively. For the remaining cultivation blocks, the correlation coefficients were r = -0.523 to r = +0.443. On cultivation blocks G, H, and O, the pH was from 7.7 to 9.0; on the remaining, it varied from 4.2 to 9.9.

Konin - Fertilized Plots

Statistical calculations did not show any significant correlation between the pH of formed soils and pioneer plant yields; however, calculations did show that the yields had a tendency to be lower as pH increased. (At pH 7.2 to 8.2 on block A, the trend is positive; at pH 7.8 to 9.3 on combination E, the trend is negative). Correlation coefficients varied from r = -0.394 to r = +0.020.

CORRELATION BETWEEN SOLUBLE BORON CONTENT IN FORMED SOILS AND PIONEER PLANT YIELDS

Halemba - Fertilized Plots

For most blocks in combinations 2 and 3, with soluble boron from 0.4 to 2.5 ppm, the correlation between boron content and plant yield was not statistically significant (r = -0.58 to + 0.62). Positive correlation was found for blocks H (double fertilization with N2PK), E (fertilization with low moor peat), and 0 (no fertilization until 1976). The average content of soluble boron in soils in these blocks was from 0.65 to 1.45 ppm.

Konin - Fertilized Plots

At a high soluble boron content in formed ash soils, the results showed high negative correlation between crop yield and the content of B on cultivated blocks:

I (fertilization with NPK) - r	= -0.97
O (not fertilized until 1976) - r	= -0.92
E (fertilization with peat + NPK) - r	= -0.84
F (fertilization with high moor peat + NPK) - r	= -0.75

No correlation was found on blocks covered with fertile soil (average boron content from 2.96 to 14.02 ppm) - r = -0.36 to + 0.10.

Analysis of correlation coefficients (Figure 49) showed that both low boron content in formed soils and excessive boron content decreased the yield (negative correlation), whereas a boron content of 6 to 13 mg/kg of soil had a small positive effect on yields (positive correlation). The range (6 to 13 ppm) may be regarded as boron tolerance limits for pioneer plants.

THE EFFECT OF SOIL SALINITY ON YIELDS OF PIONEER PLANTS

The effect of salinity of soils, measured every year in the spring, on yields of pioneer plants from combinations 2 and 3 for the period 1976-1980 was calculated. The salinity was reported as NaCl.

Halemba - Fertilized Plots

At an average salinity of 0.10 to 0.67 g NaCl/dm^3 of soil (for plots on combinations 2 and 3), a significant positive correlation was found between soil salinity and yields of pioneer plants (r = +0.85) for all plots. A high positive correlation is presented for the following cultivation blocks:

0 (no fertilization until 1976) - r	= 0.92
H (double fertilization with N2PK) - r	= 0.91
C (covered with a 5-cm layer of fertile soil) - r	= 0.88

The correlation coefficients for the remaining cultivation blocks were not statistically significant.

Konin - Fertilized Plots

At an average salinity within the ranges of 0.15 to 4.11 g NaCl/dm^3 of soil (for plots on combinations 2 and 3), no significant effect of salinity on yields of pioneer plants was found (for the whole experiment r = -0.25). A negative influence of salinity was observed, however, on cultivation blocks that had not been covered with a larger mass of fertile soil (r = -0.59 to -0.35) and where salinity values were from 2.04 to 4.11 g NaCl/dm.^{3} On cultivation blocks covered with fertile soil (salinity from 0.15 to 2.09 g NaCl), a positive effect of salinity was observed (r = +0.79 to 0.84), which is consistent with the results obtained at Halemba. Therefore, it can be concluded that

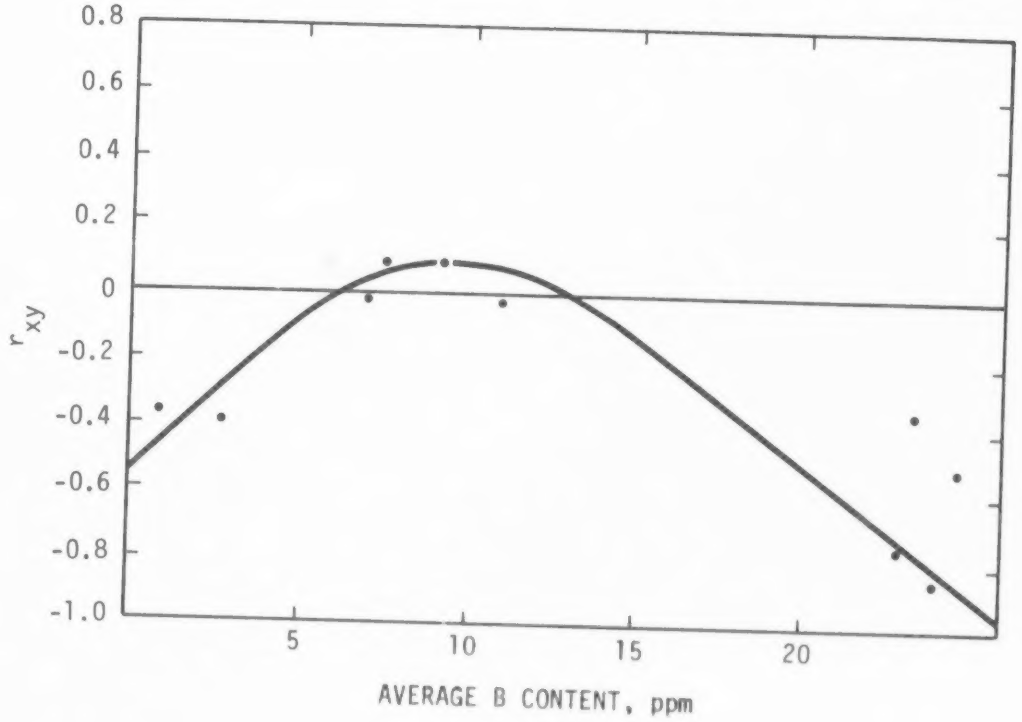


Figure 49. Correlation coefficient r of yields depending on the content of soluble B in soils.

low salinity (less than 1 g NaCl/dm³ of soil) has a positive effect on yields of mixtures of grass and legumes, whereas larger salinity (1.5 g or more of NaCl) may be toxic.

DEPENDENCE OF PIONEER PLANT YIELDS ON FERTILIZATION

Yields from combinations 2 and 3 (in the years 1975-1980) were taken into consideration in statistical tests. The content of K_2O in soils was measured every year, just after the first swarth was gathered (June).

Halemba - Fertilized Plots--
A low degree of negative correlation ($r = -0.12$) was found betwen the content of K_2O in soils and yields of pioneer plants for all experimental plots. Individual blocks have correlation coefficients ranging from $r = -0.51$ to $r = +0.518$. A low degree of positive correlation was found on the blocks of series F and O (the content of K_2O was 5.5 to 29 mg/100 g of soil and was slightly higher than on plots covered with fertile soil).

Konin - Fertilized Plots

When data for all plots were considered, a statistically significant negative correlation between K_2O content in soils and pioneer plant yields was found ($r = -0.604$); however, no significant correlations were found in a few individual blocks ($r = -0.342$ to $+0.455$).

Dependence of Yields on the Content of P_2O_5 in Soils Formed

Halemba - Fertilized Plots--
The statistical test indicated the following:

- A significant negative correlation was found between the content of P_2O_5 in soils (6.4 to 75 mg of P_2O_5/100 g of soil) and pioneer plant yields in cultivation block D (fertilized with bentonite + NPK) ($r = -0.73$).
- On the remaining cultivation blocks, no significant correlation was found ($r = -0.45 = +0.51$).

Konin - Fertilized Plots--
A statistically significant negative correlation was found between the content of P_2O_5 in formed soils and yields on combinations 2 and 3 over all experimental plots ($r = -0.48$), whereas no significant correlation was found on several particular cultivation blocks ($r = -0.19$ to $+0.15$). The high pH may inhibit the adsorption of P_2O_5 and thus affect the statistical assessment of the data.

Dependence of Yield on the Content of $CaCO_3$ in Formed Soils

Halemba - Fertilized Plots--

A statistically significant negative correlation was found between the content of $CaCO_2$ in formed soils and yields of grass and legume mixes, when all experimental plots were considered (r = -0.91). Similarly high negative correlation was found for cultivation block I (fertilized with NPK): r = -0.67. A significant positive correlation was found for block D (fertilized wth bentonite and NPK): r = +0.64, which is connected with a high content of $CaCO_3$.

Konin - Fertilized Plots--

There is a small negative correlation between the content of $CaCO_3$ in formed soils and yields of mixtures of grasses and legumes (combinations 2 and 3) for average conditions over all experimental plots (r = +0.42) and for blocks E (fertilized with low moor peat and NPK) and H (double fertilization with N2PK and green manures) (r = -0.69 and -0.76, respectively). A positive effect of $CaCO_3$ was observed for block D (r = +0.68) fertilized with acidic tertiary sand and NPK. It can be concluded that a high $CaCO_3$ content (up to 19.8 percent) causes alkalization of soil, which in turn inhibits the absorption of nutritive components.

CORRELATION BETWEEN PLANT BORON ABSORPTION AND YIELDS

The data for boron absorption by plants in the years 1976-1980 (Appendix Tables 19 and 20) and of yields from combinations 2 and 3 (Appendix Tables 5 and 6) were used in this assessment.

Halemba - Fertilized Plots

Statistical calculations indicated a significant positive correlation between boron absorption and the quantity of yields for both the whole experiment and for cultivation blocks: G (fertilized with farm manure and NPK, r = +0.86), H (fertilized with N2PK, r = +0.74), F (fertilized with high moor peat and NPK, r = +0.73), and A (covered with a 20-cm layer of fertile soil and NPK, r = +0.67). A low correlation (r = +0.30) was shown for cultivation blocks B and C (covered with a 10- or 5-cm layer of fertile soil and NPK).

Konin - Fertilized Plots

A high negative correlation was found between boron absorption and yields from all experimental plots. (r = -.0.67). The highest negative correlation (r = -0.81) was on block B (covered with a 10-cm layer of fertile soil and NPK). No correlation was found for cultivation blocks C, D, E, or G.

CORRELATION BETWEEN THE CONTENT OF K_2O IN SOILS AND THE CONTENT OF K_2O IN CROPS

Statistical calculations considered fertilized plots seeded with mixes of grasses and legumes for combinations 2 and 3. The K_2O content values in hay crops are presented in Apendix Tables 15 and 16.

Halemba

It was shown that:

- There is a statistically significant positive correlation between the K_2O content in the soil and the K_2O content in crops of pioneer plants for cultivation blocks A (covered with a 20-cm layer of fertile soil and NPK, $r = +0.62$) and O (not fertilized until 1976, $r = +0.62$).
- No correlation was observed on the remaining cultivation blocks. Correlations for blocks D (bentonite and NPK, $r = -0.43$) and G (farm manure and NPK, $r = -0.40$) are probably negative.

Konin

No significant correlation was shown between the K_2O conent in formed soils and the K_2O content in crops ($r = -0.57$ to $+0.24$).

DEPENDENCE OF K_2O CONTENT IN CROPS ON THE SALINITY OF SOILS

The K_2O content in crops is presented in Appendix Tables 15 and 16 and the salinity of soils, in Appendix Tables 47 and 48. Statistical analysis considered the plots fertilized in the years 1975-1980.

Halemba

A significant positive correlation was found only for cultivation block D (fertilized with bentonite and NPK, $r = +0.53$). On other cultivation blocks, $r = -0.19$ to $+0.40$.

Konin

It was shown that:

- There is a significant negative correlation between soil salinity and the K_2O content in crops over all experimental plots ($r = -0.39$).
- There is a significant correlation for cultivation blocks B (covered with a 10-cm layer of fertile soil and NPK, $r = +0.79$) and D (fertilized with bentonite and NPL, $r = +0.62$).
- There is no correlation for the remaining cultivation blocks ($r = +0.34$ to $+0.46$).

ASSESSMENT OF P_2O_5 CONTENT IN FORMED SOILS

Content of P_2O_5 After Neutralization Treatments and Fertilization

Statistical analysis considered the average P_2O_5 content of particular plots in the autumn of 1975. The P_2O_5 content was converted to kg/ha (Tables 51 and 52 in the Appendix).

Halemba--

At an average content of 1246 kg/ha, a statistically significant difference in P_2O_5 content was calculated for formed soils:

- Low - cultivation blocks B, A, and C, which were covered with fertile soil (368 to 740 kg/ha).
- Average - blocks G and I (971 to 1200 kg/ha).
- High - blocks O and F (1310 to 1450 kg/ha).
- Very high - blocks D, E, and H (1980-2050 kg/ha).

The high natural content of phosphorus and complementary fertilization with N and K in the following years can explain the high yields on block O.

Konin--

At an average content of 1373 kg/ha in formed soils, the following P_2O_5 contents were observed:

- Low - blocks B and A (135 to 138 kg/ha).
- Average - blocks I, G, F, O, C, D, and H (870 to 1915 kg/ha).
- High - block E (2630 kg/ha).

A large and statistically significant difference was observed within the subgroup that showed an average P_2O_5 content (the difference in P_2O_5 content between blocks I and H was 1045 kg/ha), exceeding the confidence half-interval of L = 689 kg/ha.

Assessment of P_2O_5 Losses in Formed Soils

Appendix Tables 63 and 64 present the balance of phosphorus consumption in years 1975-1980. The dependence of P_2O_5 losses on the treatment methods applied on plots in particular blocks has been analyzed.

Halemba--

A statistically significant relationship was found between P_2O_5 losses (washing out and retardation) on the method of plot treatment on particular cultivation blocks:

- A particularly high loss of P_2O_5 was observed on plots of block D fertilized with bentonite and NPK (1610 kg/ha of P_2O_5 at average losses of 372 kg/ha and a confidence interval of L = 513 kg/ha).
- No losses (absorption by plants completed with top dressing) were observed on blocks E (treated with low moor peat and NPK) and G (fertilized with farm manure and NPK). The P_2O_5 increased by 476 ±513 kg/ha and 215 ±513 kg/ha, respectively.
- On the remaining blocks, losses varied from 158 ±513 kg/ha (block D) to 540 ±513 kg/ha (block H).

High losses of phosphorus in block D coincide with the negative correlation between phosphorus absorption and yields, which was discussed earlier.

Konin--

At an P_2O_5 average loss of 431 kg/ha and a confidence interval of L = 1120 kg/ha, no statistically significant effect of the treatment methods in particular blocks on P_2O_5 losses was found. Differences in quantities of losses (+23 to -1230 kg/ha) are within the confidence half-interval L.

ASSESSMENT OF K_2O CONTENT IN FORMED SOILS

The statistical analysis took into account both the K_2O content in soils of the plots established in 1975 and the neutralizing-cultivation treatments on particular blocks. The K_2O was converted to kg/ha (Appendix Tables 15 and 16).

Content of K_2O in Soils After Neutralization and Fertilization in the Spring of 1975

Halemba--

The average K_2O content in soils was 600 kg/ha, and the confidence interval was $L_{0.05} = 107$ kg/ha, at $F_o = 11.05 > F_{0.05} = 2.40$.

Statistically significant differences in K_2O content are as follows:

- High content (1080 kg/ha) - Cultivation block D.
- Very high content (745 kg/ha) - blocks G and H.
- Considerable content (615 to 555 kg/ha) - blocks E, C, B, and I.
- Satisfactory content (445 kg/ha) - block F.
- Lowest content (350 to 345 kg/ha) - Blocks O and A.

Konin--

The average K_2O content in formed soils (707 kg/ha) was slightly higher than at Halemba. Confidence interval $L_{0.05} = 107$ kg/ha, $F_o = 16.95 > F_{0.05} = 2.98$.

The test for statistical significance showed:

- Very high content in cultivation block D, fertilized with sand and NPK (1570 kg/ha).
- High content in cultivation blocks E, O, F, I, and H (860 to 695 kg/ha).
- Satisfactory content in cultivation blocks D and C (450-435 kg/ha).
- Lowest content in cultivation blocks B and A (295-265 kg/ha).

Assessment of K_2O Losses on Agricultural Reclamation Plots

A balance of K_2O content and losses during cultivation of pioneer plants (1975-1980) is presented in Appendix Tables 65 and 66.

A test was performed to determine the dependence of K_2O loss on plot treatment in 1975.

Halemba--

The average loss of K_2O (washed out) was 222 kg/ha at the confidence half-interval $L_{0.05} = 272$ kg/ha, $F_o = 2.96 > F_{0.05} = 2.46$.

Losses of K_2O dependent on the treatment method applied in 1975 are specified in groups, starting from the highest:

- Cultivation block D (838 kg/ha)
- Cultivation block B (405 kg/ha)
- Cultivation blocks C and I (265 to 250 kg/ha)
- Cultivation blocks H, A, E, G, and F (166 to 50 kg/ha)
- Cultivation block O - a K_2O content increase of 33 kg/ha may have been caused by salts rising from a deep layer or by errors made in the measurement of the K_2O content in soil and plants.

Konin--

The average loss of K_2O on the experimental field was 431 kg/ha. The confidence half-interval $L_{0.05} = 332$ kg/ha,

$$F_o = 3.286 > F_{0.05} = 2.40$$
$$< F_{0.01} = 3.45.$$

Statistically significant differences were found in K_2O losses depending on the method of plot treatment before seeding pioner plants. Losses of K_2O are arranged in four groups (from the highest to the lowest):

- Cultivation block G (1042 kg/ha)
- Cultivation blocks E, F, O, I and D (losses 677 to 447 kg/ha)
- Cultivation blocks C and H (losses 288 to 254 kg/ha)
- Cultivation blocks B and A (losses 73 to 0 kg/ha)

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Consumption of material per 1 ha of reclaimed land

Halemba

Table 1

No.	Materials	Unit	Combinations of cultures														
			A			B			C			D			E		
			combinations of herbaceous plants and legumes														
			2	3	4	2	3	4	2	3	4	1	2	3	1	2	3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Year I/1975																
I.1	Fertile soil	1000 m3	2,0	2,0	2,0	1,0	1,0	1,0	0,5	0,5	0,5						
I.2	Bentonite	m3															
I.3	Low moor peat /dry mass/	t										100	100	100			
I.4	High moor peat /dry mass/	t													10	10	10
I.5	Farm manure	t															
I.6	Mineral fertilizers in pure component:																
I.6-1	- N	kg	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
I.6-2	- P_2O_5	kg	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
I.6-3	- K_2O	kg	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
I.7	Seeds of grasses:																
I.7-1	- meadow fescue	kg	12			12			12				12			12	
I.7-2	- orchard grass	kg	4	6		4	6		4	6			4	6		4	6
I.7-3	- awnless bromegrass	kg	12			12			12				12			12	
I.7-4	- Kentucky bluegrass	kg	5			5			5				5			5	
I.7-5	- red fescue	kg	17			17			17				17			17	
I.7-6	- tall oat-grass	kg	13			13			13				13			13	
I.7-7	- redtop	kg	4			4			4				4			4	
I.8	Seeds of legumes:																
I.8-1	- black medic	kg	7			7			7			50	7		50	7	
I.8-2	- white melilot	kg	5		50	5		50	5		50	10	5		10	5	
I.8-3	- white clover	kg	3			3			3				3			3	
I.8-4	- purple medic	kg		36			36			36				36			36

Table 1. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I.9	Latex	dm^3	833	833	833	833	833	833	833	833	833	833	833	833	833	833	833
	Year II/1976																
II.1	Mineral fertilizers in pure component:																
II.1-1	- N	kg	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
II.1-2	- P_2O_5	kg	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
II.2	Seeds of grasses:																
II.2-1	- orchard grass	kg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
II.3	Seeds of legumes:																
II.3-1	- purple medic	kg	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
	Year III/1977 /fertilized plots/																
III.1	Mineral fertilizers in pure component:																
III.1-1	- N	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
III.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	Year IV/1978 /fertilized plots/																
IV.1	Mineral fertilizers in pure component:																
IV.1-1	- N	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
IV.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	Year V/1979 /fertilized plots/																
V.1	Mineral fertilizers in pure component:																
V.1-1	- N	kg	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
V.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
V.1-3	- K_2O	kg	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
V.1-4	- MgO	kg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
V.1-5	- microelements /B, Mn, Zn, Cu, Mo, Co/		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Table 1. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
VI.1	Year VI/1980 /fertilized plots/																
	Mineral fertilizers in pure component:																
VI.1-1	- N	kg	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
	- P_2O_5	kg	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
	- K_2O	kg	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480
	- MgO	kg	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	- microelements /B, Zn, Mn, Cu, Mo/		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VI.2	Seeds of barley	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Year VI/1980 /non-fertilized plots/																
VI.a.1	Mineral fertilizers in pure component /for barley/																
VIa.1-1	- K_2O	kg	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
VIa.1-2	- P_2O_5	kg	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
VIa.2	Seeds of barley	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Year VII/1981 /all plots/																
VII.1	Mineral fertilizers in pure component /top dressing/																
	- N / I dose/	kg	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
	- N / II dose/	kg	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

Consumption of material per 1 ha of reclained land
Halemba

Table 2

No.	Materials	Unit	Combinations of cultures														
			F			G			H			I			O		
			combinations of herbaceous plants and legumes														
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Year I/1975																
I.1	Fertile soil	1000 m^3															
I.2	Bentonite	m^3															
I.3	Low moor peat	t															
I.4	High moor peat	t	10	10	10												
I.5	Farm manure	t				20	20	20									
I.6	Mineral fertilizers in pure component:																
I.6-1	- N	kg	140	140	140	140	140	140	140	140	140	140	140	140	20	20	20
I.6-2	- P_2O_5	kg	210	210	210	210	210	210	350	350	350	210	210	210			
I.6-3	- K_2O	kg	30	30	30	30	30	30	30	30	30	30	30	30			
I.7	Seeds of grasses:																
I.7-1	- meadow fescue	kg		12			12			12			12			12	
I.7-2	- orchard grass	kg		4	6		4	6		4	6		4	6		4	6
I.7-3	- awnless bromegrass	kg		12			12			12			12			12	
I.7-4	- Kentucky bluegrass	kg		5			5			5			5			5	
I.7-5	- red fescue	kg		17			17			17			17			17	
I.7-6	- tall oat-grass	kg		13			13			13			13			13	
I.7-7	- red top	kg		4			4			4			4			4	
I.8	Seeds of legumes:																
I.8-1	- black medic	kg	50	7		50	7		50	7		50	7		50	7	
I.8-2	- while melilot	kg	10	5		10	5		10	5		10	5		10	5	
I.8-3	- white clover	kg		3			3			3			3			3	
I.8-4	- purple medic	kg			36			36			36			36			36

Table 2. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I.9	Latex	dm^3	833	833	833	833	833	833	833	833	833	833	833	833	833	833	833
	Year II/1976																
II.1	Mineral fertilizers in pure component:																
II.1-1	- N	kg	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
II.1-2	- P_2O_5	kg	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
II.2	Seeds of grasses:																
II.2-1	- orchard grass	kg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
II.3	Seeds of legumes:																
II.3-1	- purple medic	kg	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
	Year III/1977 /fertilized plots/																
III.1	Mineral fertilizers in pure component:																
III.1-1	- N	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
III.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	Year IV/1978 /fertilized plots/																
IV.1	Mineral fertilizers in pure component:																
IV.1-1	- N	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
IV.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	Year V/1979 /fertilized plots/																
V.1	Mineral fertilizers in pure component:																
V.1-1	- N	kg	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
V.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
V.1-3	- K_2O	kg	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
V.1-4	- MgO	kg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
V.1-5	- microelements /B, Zn, Mn, Cu, Mo, Co/		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Table 2. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Year VI/1980 /fertilized plots/																
VI.1	Mineral fertilizers in pure component:																
VI.1-1	- N	kg	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
VI.1-2	- P_2O_5	kg	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
VI.1-3	- K_2O	kg	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480
VI.1-4	- MgO	kg	60	50	50	60	60	60	60	60	50	50	60	60	50	50	60
VI.1-5	- microelements /B, Zn, Mn, Cu, Mo/		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VI.2	Seeds of barley	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Year VI/1980 /non-fertilized plots/																
VI.a.1	Mineral fertilizers in pure component /before sowing of barley/																
VIa.1-1	- K_2O	kg	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
VIa.1-2	- P_2O_5	kg	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
VIa.2	Seeds of barley	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Year VII/1981 /all plots/																
VII.1	Mineral fertilizers in pure component.																
VII.1-1	- N /I top-dress dose/	kg	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
	- N /II top-dress dose/	kg	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

Consumption of material per 1 ha land
Konin

Table 3

No.	Materials	Unit	Combinations of cultures														
			A			B			C			D			E		
			combinations of herbaceous plants and grasses														
			2	3	4	2	3	4	2	3	4	1	2	3	1	2	3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Year I/1975																
I.1	Fertile soil	1000 m^3	2,0	2,0	2,0	1,0	1,0	1,0	0,5	0,5	0,5						
I.2	Tertiary acidicic sand	1000 m^3										0,5	0,5	0,5			
I.3	Low moor peat /dry mass/	t													10	10	10
I.4	High moor peat /dry mass/	t															
I.5	Farm manure	t															
I.6	Green manure	t															
I.7	Mineral fertilizers in pure component:																
I.7-1	- N	kg	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155
I.7-2	- P_2O_5	kg	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370
I.7-3	- K_2O	kg	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
I.8	Seeds of grasses:																
I.8-1	- meadow fescue	kg	12			12			12				12			12	
I.8-2	- orchard grass	kg	4	6		4	6		4	6			4	6		4	6
I.8-3	- awnless bromegrass	kg	12			12			12				12			12	
I.8-4	- Kentucky bluegrass	kg	5			5			5				5			5	
I.8-5	- red fescue	kg	17			17			17				17			17	
I.8-6	- tall oat-grass	kg	13			13			13				13			13	
I.8-7	- redtop	kg	4			4			4				4			4	
I.9	Seeds of legumes:																
I.9-1	- sainfoin	kg										140			140		
I.9-2	- crown vetch	kg										70			70		
I.9-3	- white clover	kg	3			3			3				3			3	

Table 3. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I.9-4	- black medic	kg	7			7			7				7			7	
I.9-5	- white sweetclover	kg	5		50	5		50	5		50		5			5	
I.9-6	- purple medic	kg		36			36			36				36			36
I.10	Latex	dm^3	833	833	833	833	833	833	833	833	833	833	833	833	833	833	833
	Year II/1976																
II.1	Mineral fertilizers in pure component:																
II.1-1	- N	kg	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
II.1-2	- P_2O_5	kg	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
II.2	Seeds of grasses:																
II.2-1	- meadow fescure	kg	24			24			24				24			24	
II.2-2	- orchard grass	kg	8	12		8	12		8	12			8	12		8	12
II.2-3	- awnless bromegrass	kg	24			24			24				24			24	
II.2-4	- Kentucky bluegrass	kg	10			10			10				10			10	
II.2-5	- red fescue	kg	34			34			34				34			34	
II.2-6	- tall oat-grass	kg	26			26			26				26			26	
II.2-7	- redtop	kg	8			8			8				8			8	
II.3	Seeds of legumes:																
II.3-1	- sainfoin	kg										280			280		
II.3-2	- white clover	kg	6			6			6				6			6	
II.3-3	- black medic	kg	14			14			14				14			14	
II.3-4	- white sweetclover	kg	6		100	6		100	6		100		6			6	
II.3-5	- purple medic	kg		72			72			72				72			72
	Year III/1977 /fertilized plots/																
III.1	Mineral fertilizers in pure component:																
III.1-1	- N	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
III.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	Year IV/1978 /fertilized plots/																
IV.1	Mineral fertilizers in pure component:																
IV.1-1	- N	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
IV.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	Year V/1979 /fertilized plots/																
V.1	Mineral fertilizers in pure component:																

Table 3. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
V.1-1	- N	kg	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
V.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
V.1-3	- K_2O	kg	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
V.1-4	- MgO	kg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
V.1-5	- microelements /B, Zn, Mn, Cu, Mo, Co/		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Year VI/1980 /fertilized plots/																
VI.1	Mineral fertilizers in pure component:																
VI.1-1	- N	kg	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
VI.1-2	- P_2O_5	kg	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
VI.1-3	- K_2O	kg	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480
VI.1-4	- MgO	kg	60	60	60	60	60	60	60	60	60	60	60	60	60	60	50
VI.1-5	- microelements /B,Zn,Mn,Cu,Mo/		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VI.2	Seeds of barley	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Year VI/1980 /non-fertilized plots/																
VIa.1	Mineral fertilizers in pure component /for barley/																
VIa.1-1	- K_2O	kg	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
VIa.1-2	- P_2O_5	kg	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
VIa.2	Seeds of barley	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Year VII/1981 /all plots/																
VII.1	Mineral fertilizers in pure component /top dressing/:																
	- N /I dose/	kg	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
	- N /II dose/	kg	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

Consumption of materials per 1 ha of reclaimed land
Konin

Table 4

No.	Materials	Unit	Combinations of cultures														
			P			G			H /T/			I			O		
			combinations of herbaceous plants and grasses														
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Year I/1975																
I.1	Fertile soil	1000 m^3															
I.2	Acidic tertiary sand	1000 m^3				–											
I.3	Low moor peat /dry mass/	t															
I.4	High moor peat /dry mass/	t	10	10	10												
I.5	Farm manure	t				20	20	20									
I.6	Green manure	t							40	40	40						
I.7	Mineral fertilizers in pure component:																
I.7-1	– N	kg	155	155	155	155	155	155	340	340	340	155	155	155	60	60	60
I.7-2	– P_2O_5	kg	370	370	370	370	370	370	670	670	670	370	370	370	90	90	90
I.7-3	– K_2O	kg	30	30	30	30	30	30	30	30	30	30	30	30			
I.8	Seeds of grasses:																
I.8-1	– meadow fescue	kg		12			12			12			12			12	
I.8-2	– orchard grass	kg		4	6		4	6		4	6		4	6		4	6
I.8-3	– awnless bromegrass	kg		12			12			12			12			12	
I.8-4	– Kentucky blue grass	kg		5			5			5			5			5	
I.8-5	– red fescue	kg		17			17			17			17			17	
I.8-6	– tall oat-grass	kg		13			13			13			13			13	
I.8-7	– redtop	kg		4			4			4			4			4	
I.9	Seeds of legumes:																
I.9-1	– sainfoin	kg	140			140			140			140			140		
I.9-2	– crownvetch	kg	70			70			70			70			70		
I.9-3	– white clover	kg		3			3			3			3			3	
I.9-4	– black medic	kg		7			7			7			7			7	

Table 4. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I.9-5	- white sweetclover	kg		5			5			5			5			5	
I.9-6	- purple medic	kg			36			36			36			36			36
I.10	Latex	dm^3	833	833	833	833	833	833	833	833	833	833	833	833	833	833	833
	Year II/1976																
II.1	Mineral fertilizers in pure component:																
II.1-1	- N	kg	150	150	150	150	150	150	150	150	150	150	150	150			
II.1-2	- P_2O_5	kg	110	110	110	110	110	110	110	110	110	110	110	110			
II.2	Seeds of grasses:																
II.2-1	- meadow fescue	kg		24			24			24			24			24	
II.2-2	- orchard grass	kg		8	12		8	12		8	12		8	12		8	12
II.2-3	- awnless bromegrass	kg		24			24			24			24			24	
II.2-4	- Kentucky blue grass	kg		10			10			10			10			10	
II.2-5	- red fescue	kg		34			34			34			34			34	
II.2-6	- tall oat-grass	kg		26			26			26			26			26	
II.2-7	- redtop	kg		8			8			8			8			8	
II.3	Seeds of legumes:																
II.3-1	- sainfoin	kg	280			280			280			280			280		
II.3-2	- white clover	kg		6			6			6			6			6	
II.3-3	- black medic	kg		14			14			14			14			14	
II.3-4	- white sweetclover	kg		6			6			6			6			6	
II.3-5	- purple medic	kg			72			72			72			72			72
	Year III/1977 /fertilized plots/																
III.1	Mineral fertilizers in pure component:																
III.1-1	- N	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
III.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	Year IV/1978 /fertilized plots/	-															
IV.1	Mineral fertilizers in pure component:																
IV.1-1	- N	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
IV.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120

Table 4. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Year, V/1979/fertilized plots/																
V.1	Mineral fertilizers in pure component:																
V.1-1	- N	kg	270	270	270	279	270	270	270	270	270	270	270	270	270	270	270
V.1-2	- P_2O_5	kg	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
V.1-3	- K_2O	kg	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
V.1-4	- MgO	kg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
V.1-5	- microelements /B,Zn,Mn,Cu,Mo,Co/		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Year VI/1980/fertilized plots/																
VI.1	Mineral fertilizers in pure component:																
VI.1-1	- N	kg	270	270	270	270	270	270	270	270	270	270	270	270	270	270	279
VI.1-2	- P_2O_5	kg	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
VI.1-3	- K_2O	kg	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480
VI.1-4	- MgO	kg	60	50	60	60	60	50	60	60	60	50	50	50	50	50	60
VI.1-5	- microelements /B,Zn,Mn,Cu,Mo/	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
VI.2	Seeds of barley	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Year VI/1980 /non-fertilized plots/																
VIa.1	Mineral fertilizers in pure component /for barley/:																
VIa.1-1	- K_2O	kg	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
VIa.1-2	- P_2O_5	kg	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
VIa.2	Seeds of barley	kg	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Year VII/1981 /all plots/																
VII.1	Mineral fertilizers in pure component /top dressing/:																
	- N / I dose/	kg	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
	- N /II dose/	kg	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

Crops of hay from experimental plots

Halemba

Table 5

No. of plot	Combinations of soils and fertilizers	No. of mixture	Crops of hay [t/ha]																
			1975	1976			1977			1978			1979			1980			Total in the period 1975–1980
				I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	4.03	3.69	2.51	6.20	5.75	5.07	10.82	3.18	2.44	5.62	5.98	3.49	9.47	4.09	9.91	14.00	50.14
		2a					3.4	2.4	5.8	1.19	1.22	2.41	3.31	0.92	4.23	0.97	2.51	3.48	26.25
A-3	-"-	3	2.69	2.93	2.19	5.12	4.20	2.91	7.11	2.09	1.72	3.81	4.17	2.68	6.85	3.54	7.07	10.61	36.19
		3a					2.1	1.5	3.6	0,57	0.60	1.17	1.11	0.40	1.51	0.30	1.12	1.42	15.51
A-4	-"-	4	1.53	1.63	1.78	3.41	4.97	4.73	9.70	4.07	1.72	5.79	3.62	3.78	7.40	2.57	7.27	9.84	37.67
		4a					2.5	4.1	6.6	2.60	1.02	3.62	1.93	1.22	3.15	0,68	1.78	2.46	20.77
B-2	Ash + 10 cm of fertile soil + NPK	2	2.82	2.32	1.24	4.56	4.39	4.29	8.68	3.03	1.51	4.54	3.78	4.68	8.46	2.65	6.92	9.57	38.63
		2a					2.3	2.6	4.9	1.21	0,75	1.96	1.69	1.62	3.31	0.76	1.61	2.37	19.92
B-3	-"-	3	2.12	2.27	1.20	3.37	3.44	3.39	6.82	2.16	1.17	3.33	2.72	2.42	5.14	2.32	4.77	7.09	27.97
		3a					1.9	2.0	3.9	0.60	0.24	0.84	0.91	0,84	1.85	0.72	1.73	2.45	14.53
B-4	-"-	4	1.26	1.90	1.21	3.11	3.28	5.29	8.57	2.85	1.65	4.50	3.60	3.39	6.99	2.91	7.67	10.58	35.01
		4a					1.8	3.6	5.4	2.69	1.26	3.95	2.29	1.38	3.67	1.66	3.79	5.45	22.84
C-2	Ash + 5 cm of fertile soil + NPK	2	1.54	1.70	0.85	2.55	3.62	4.67	8.29	2.76	1.55	4.31	3.84	2.68	6.52	2.04	7.44	9.48	32.69
		2a					1.9	2.0	3.9	1.71	1.47	3.18	1.65	1.96	3.61	1.50	4.30	5.80	20.58
C-3	-"-	3	1.65	2.10	1.05	3.15	3.01	2.68	5.69	1.55	1.34	2.89	2.43	2.54	4.97	1.41	6.64	8.05	26.40
		3a					1.7	1.4	3.1	0.58	0.28	0.86	0,84	0.89	1.73	0.54	2.81	3.35	13.84
C-4	-"-	4	0.62	0.90	0.77	1.67	2.74	3.28	5.02	2.49	2.01	4.50	3.49	3.22	6.71	3.07	5.69	8.76	27.28
		4a					1.3	2.5	3.8	2.31	1.60	3.91	2.54	1.91	4.45	2.03	4.73	6.76	21.21
D-1	Ash + Bentonite + NPK	1	1.27	1.28	0.68	1.96	3.08	3.60	6.68	2.49	1.71	4.20	3.18	2.68	5.86	2.61	5.77	8.38	28.35
		1a					1.5	2.8	4.3	2.15	1.00	3.15	1.90	1.52	3.42	1.75	5.25	7.00	21.10
D-2	-"-	2	0.60	0.86	0.39	1.25	2.56	2.20	4.76	1.87	1.37	3.24	1.93	2.13	4.06	2.52	4.98	7.50	21.41
		2a					1.5	2.3	3.8	1.51	1.16	2.67	1.62	1.57	3.19	1.79	3.56	5.35	16.86
D-3	-"-	3	1.25	0.95	0.63	1.58	2.62	2.89	5.51	1.43	1.38	2.81	2.19	2.05	4.24	1.61	5.97	7.58	22.97
		3a					1.9	1.2	3.1	0.57	0.47	1.04	1.75	2.11	3.86	1.50	4.05	5.55	16.38
E-1	Ash + low moor peat + NPK	1	3.50	1.31	1.79	3.10	6.08	4.91	10.99	2.96	1.56	4.52	4.73	2.43	7.16	2.42	6.47	8.89	38.16
		1a					4.3	4.4	8.7	1.81	1.26	3.07	1.56	1.47	3.03	0.72	1.89	2.61	24.01
E-2	-"-	2	1.25	1.38	0.75	2.13	5.16	4.45	9.61	2.22	1.30	3.52	3.09	2.93	6.02	2.25	6.04	8.29	30.82
		2a					3.8	2.4	6.2	0.79	0.64	1.43	1.23	1.46	2.69	0.83	1.94	2.77	16.47
E-3	-"-	3	1.29	1.11	0.57	1.68	3.38	3.30	6.68	1.99	1.59	3.58	3.36	3.06	6.42	1.88	7.35	9.23	28.88
		3a					3.2	1.6	4.8	0.55	0.14	0.69	0.74	0.76	1.50	0.55	1.99	2.54	12.50

Table 5. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
F-1	Ash + high moor plat + NPK	1	1.30	1.49	0.45	1.94	4.87	2.84	7.71	2.22	1.63	3.85	3.01	2.28	5.29	3.06	5.92	8.98	29.07
		1a					3.5	3.5	7.0	2.65	0.86	3.51	0.93	0.97	1.90	0.86	2.83	3.69	19.34
F-2	-"-	2	0.12	0.13	0.22	0.35	3.67	2.27	5.94	2.52	0.95	3.47	2.52	2.34	4.86	1.81	5.68	7.49	22.23
		2a					2.3	2.7	5.0	1.69	0.91	2.60	1.54	2.10	3.64	1.14	3.56	4.70	16.41
F-3	-"-	3	0.15	0.27	0.17	0.44	3.63	2.17	5.70	1.32	1.01	2.33	2.24	2.23	4.47	1.70	6.20	7.90	20.99
		3a					2.2	2.2	4.4	0.62	0.30	0.92	1.08	1.65	2.23	1.48	4.45	5.93	14.57
G-1	Ash + farm manure + NPK	1	0.45	0.75	0.23	0.98	3.99	1.77	5.76	2.20	1.10	3.30	2.23	2.78	5.01	2.31	5.91	8.22	23.72
		1a					2.7	2.0	4.7	2.09	1.00	3.09	1.69	2.32	4.01	1.55	5.34	6.89	20.12
G-2	-"-	2	0.09	0.35	0.35	0.70	4.37	1.81	6.18	2.19	1.12	3.31	2.37	2.86	5.23	1.67	6.30	7.97	23.48
		2a					3.2	1.9	5.1	1.33	0.65	1.98	1.70	2.32	4.02	1.02	5.90	6.92	18.81
G-3	-"-	3	0.59	1.07	0.47	1.54	4.00	1.95	5.95	1.47	1.36	2.83	1.35	2.66	4.01	1.38	6.29	7.67	22.59
		3a					2.9	2.0	4.9	0.88	0.35	1.23	3.40	2.09	5.49	1.42	4.30	5.72	19.47
H-1	Ash + N2PK	1	1.02	1.59	0.34	1.93	2.87	2.86	5.73	2.40	1.62	4.02	3.76	2.89	6.65	1.89	7.11	9.00	28.35
		1a					2.1	2.9	5.0	1.60	0.83	2.43	1.40	1.43	2.83	0.59	4.82	5.41	18.62
H-2	-"-	2	0.41	0.93	1.03	1.96	3.64	3.18	6.82	2.53	1.62	4.15	3.46	3.25	6.71	2.09	7.31	9.40	29.45
		2a					2.6	2.6	5.2	1.42	0.74	2.16	1.48	1.43	2.91	0.34	3.23	3.57	16.21
H-3	-"-	3	0.77	2.13	1.39	3.52	2.86	2,78	5.64	2.12	1.74	3.86	3.15	2.79	5.94	1.35	6.57	7.92	27.65
		3a					2.1	1.7	3.8	0.79	0.14	0.93	0.76	0.49	1.25	0.82	0.97	1.79	12.06
I-1	Ash + NPK	1	0.86	0.43	0.28	0.71	2.52	2.26	4.78	2.02	1.62	3.64	2.79	2.19	4.98	2.98	5.18	8.16	23.13
		1a					1.8	0.9	2.7	0.91	0.59	1.50	2.06	1.50	3.56	1.58	3.20	4.78	14.11
I-2	-"-	2	0.39	0.77	0.38	1.15	2.93	2.79	5.72	2.06	1.33	3.39	2.54	2.49	5.03	2.23	5.73	7.96	23.64
		2a					2.1	1.8	3.9	1.27	0.78	2.05	2.62	2.42	5.04	1.84	3.71	5.55	18.08
I-3	-"-	3	1.67	1.32	0.56	1.88	2.34	2.63	4.97	1.43	1.22	2.65	2.76	1.71	4.47	1.81	6.07	7.88	23.52
		3a					2.1	1.8	3.9	0.76	0.44	1.20	2.46	1.98	4.44	1.62	3.05	4.67	17.76
0-1	Ash without fertilization till 1976 /control/	1	2.06	1.29	0.96	2.25	2.51	2.66	5.17	2.29	1.13	3.42	3.22	2.16	5.38	2.22	6.51	8.73	27.01
		1a					1.5	2.6	4.1	2.13	1.13	3.26	2.14	1.08	3.22	0.33	1.59	2.52	17.41
0-2		2	0.11	1.01	1.06	2.07	2.12	2.39	4.51	1.54	1.25	2.79	3.20	2.91	6.11	1.83	6.99	8.82	24.41
		2a					2.2	2.5	4.7	0.66	0.98	1.64	1.71	1.27	2.98	0.37	3.20	3.57	15.07
0-3		3	1.66	1.66	1.32	2.98	2.40	1.41	3.81	1.52	1.40	2.92	3.25	2.72	5.97	1.50	6.83	8.33	25.67
		3a					2.2	1.3	3.5	0.59	0.22	0.81	0.95	0.42	1.37	0.46	0.96	1.42	11.74

Note:

"a" in the column 3 denotes plots nonfertilized in 1977-1980

Crops of hay from experimental plots

Konin

Table 6

No of plot	Combinations of soils and fertilizers	No. of mixture	Crops of hay [t/ha]																
			1975	1976			1977			1978			1979			1980			total for the period 1975-1980
				I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil → NPK	2	-	2.99	2.11	5.10	8.31	5.47	13,78	5.98	3.27	9.25	4.36	-	4.36	4.59	8.30	12.89	45.38
		2a					5.1	1.0	6.1	1.89	0.43	2.32	0.61	-	0.61	0.52	1.86	2.38	16.51
A-3	-"-	3	-	2.97	1.45	4.42	9.11	5.16	14.27	4.84	2.39	7.23	3.09	-	3.09	4.42	7.99	12.41	41.42
		3a					5.8	2.5	8.3	2.70	0.83	3.53	1.15	-	1.15	0.56	1.38	1.94	19.34
A-4	-"-	4	-	0.81	0.45	1.26	5.12	3.45	8.57	2.49	1.88	4.37	2.94	-	2.94	3.78	7.96	11.74	28.88
		4a					3.1	1.7	4.8	1.22	0.57	1.79	0.88	-	0.88	0.41	2.28	2.69	11.42
B-2	Ash + 10 cm of fertile soil + NPK	2	-	2.85	1.98	4.83	8.67	4.01	12.68	4.63	3.44	8.07	3.26	-	3.26	5.80	7.97	13.77	42.61
		2a					3.6	0.7	4.3	1.62	0.40	2.02	0.82	-	0.82	0.63	2.34	2.97	14.94
B-3	-"-	3	-	2.34	1.65	3.99	7.72	4.42	12.14	4.95	3.16	8.11	3.58	-	3.58	5.10	10.28	15.38	43.20
		3a					5.5	3.0	8.5	3.00	1.39	4.39	1.69	-	1.69	1.20	4.14	5.34	23.91
B-4	-"-	4	-	0.77	0.76	1.55	4.64	3.23	7.87	2.72	2.73	5.45	2.44	-	2.44	4.66	13.61	18.27	35.58
		4a					2.4	1.4	3.9	1.35	0.51	1.86	0.64	-	0.64	0.71	4.88	5.59	13.54
C-2	Ash + 5 cm of fertile soil + NPK	2	-	2.43	1.82	4.25	7.42	3.54	10.66	3.86	2.51	6.37	2.92	-	2.92	4.56	6.65	11.21	35.41
		2a					3.0	0.6	3.6	1.46	0.36	1.82	1.30	-	1.30	0.74	2.56	3.30	14.27
C-3	-"-	3	-	2.20	1.43	3.63	7.12	3.54	10.66	4.27	2.92	7.19	2.99	-	2.99	3.42	8.97	12.39	36.86
		3a					4.9	2.1	7.0	1.13	1.02	2.15	1.30	-	1.30	1.05	3.03	4.08	18.16
C-4	-"-	4	-	0.44	0.81	1.25	3.18	2.36	5.54	2.90	2.27	5.17	2.24	-	2.24	4.66	5.45	10.11	24.33
		4a					3.1	1.2	4.3	1.30	0.66	1.96	0.76	-	0.76	0.41	2.17	2.58	10.85
D-1	Ash + tertiary sanol + NPK	1	-	0.04	-	0.04	3.64	0.30	3.94	3.26	1.60	4.86	2.54	-	2.54	3.46	10.68	14.14	25.52
		1a					2.3	-	2.3	1.02	0.27	1.29	1.04	-	1.04	1.08	4.64	5.72	10.39
D-2	-"-	2	-	1.89	1.26	3.15	5.33	2.29	7.62	3.22	3.53	6.75	2.95	-	2.95	4.42	10.97	15.39	35.86
		2a					2.4	0.5	2.9	2.45	0.55	3.00	0.49	-	0.49	0.32	0.48	2.80	12.34
D-3	-"-	3	-	1.83	1.28	3.11	5.17	2.45	8.22	3.67	2.28	5.95	3.08	-	3.08	3.09	10.79	13.88	34.24
		3a					2.7	0.3	3.0	1.36	0.92	2.28	1.29	-	1.29	0.92	3.46	4.38	14.06
E-1	Ash + low moor peat + NPK	1	-	-	-	-	3.42	0.14	3.53	3.08	2.14	5.22	2.11	-	2.11	4.59	10.48	15.07	25.93
		1a					2.1	-	2.1	0.82	0.47	1.29	1.42	-	1.42	1.82	3.52	5.34	10.15
E-2	-"-	2	-	0.19	0.29	0.48	5.73	3.32	9.05	5.00	3.74	8.74	3.30	-	3.30	5.52	11.28	16.80	38.37
		2a					3.0	0.8	3.8	1.19	0.72	1.91	0.66	-	0.66	0.42	3.59	4.01	10.86
E-3	-"-	3	-	0.05	0.64	0.69	6.36	3.13	9.49	4.86	2.42	7.28	3.89	-	3.89	4.19	8.43	12.62	33.97
		3a					5.3	1.9	7.2	3.33	1.06	4.39	2.13	-	2.13	1.62	3.69	5.31	19.72
..	..																		

Table 6. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
F-1	Ash + high moor peat + NPK	1	-	-	-	-	3.53	-	3.53	3.71	1.69	5.40	2.03	-	2.03	3.28	7.34	10.62	21.58
		1a					2.1	-	2.1	0.96	0.51	1.47	1.50	-	1.50	1.91	3.48	5.39	10.46
F-2	-"-	2	-	0.13	0.47	0.60	6.62	2.51	9.13	4.25	3.55	7.80	2.69	-	2.69	4.89	11.66	16.55	36.77
		2a					4.2	0.9	5.1	1.40	0.61	2.01	0.40	-	0.40	0.39	4.04	4.43	12.54
F-3	-"-	3	-	0.12	0.06	0.18	5.91	2.49	8.40	4.37	2.27	6.64	3.73	-	3.73	4.68	8.67	13.35	32.30
		3a					5.6	2.1	7.7	2.90	0.98	3.97	2.29	-	2.29	1.86	4.23	6.09	20.23
G-1	Ash + farm manure + NPK	1	-	0.20	-	0.20	4.69	0.28	4.97	3.94	1.71	5.65	2.19	-	2.19	3.64	8.68	12.32	25.33
		1a					3.0	-	3.0	1.40	0.44	1.84	1.24	-	1.24	1.16	4.32	5.48	11.76
G-2	-"-	2	-	3.16	1.08	4.24	9.92	2.48	12.40	4.85	4.01	8.86	3.21	-	3.21	4.15	8.32	12.47	41.18
		2a					4.2	0.7	4.9	1.44	0.60	2.04	0.64	-	0.64	0.44	4.11	4.55	16.37
G-3	-"-	3	-	2.48	1.33	3.81	8.28	3.13	11.41	6.06	3.56	9.62	3.42	-	3.42	3.23	6.76	9.99	38.25
		3a					6.4	2.6	9.0	4.09	1.19	5.28	1.56	-	1.56	1.70	4.56	6.26	25.91
H/K/1	Ash + N2PK + green manure /corn/	1	-	-	-	-	4.96	-	4.96	2.91	1.28	4.19	1.44	-	1.44	3.14	7.98	11.12	21.71
		1a					4.5	-	4.5	1.07	0.18	1.25	0.67	-	0.67	1.88	3.81	5.69	12.11
H/K/-2	-"-	2	-	-	0.62	0.62	7.38	2.55	9.93	5.56	3.17	8.73	2.49	-	2.49	4.02	9.03	13.05	34.82
		2a					6.8	1.2	8.0	1.90	0.56	2.46	0.76	-	0.76	0.39	2.96	3.35	15.19
H/K-3	-"-	3	-	-	0.02	0.02	6.15	2.72	8.87	5.82	2.81	8.63	4.73	-	4.73	3.89	7.98	11.87	34.12
		3a					5.4	1.8	7.2	3.68	0.89	4.57	2.54	-	2.54	1.68	2.96	4.64	18.97
I-1	Ash + NPK	1	-	-	-	-	3.55	-	3.55	3.67	1.26	4.93	2.77	-	2.77	4.19	8.58	12.77	24.02
		1a					2.0	-	2.0	0.81	0.31	1.12	1.38	-	1.38	1.93	2.77	4.70	9.20
I-2	-"-	2	-	-	0.36	0.36	7.60	1.69	9.29	4.20	3.33	7.53	3.09	-	3.09	4.89	9.05	13.94	34.21
		2a					4.6	0.7	5.3	1.01	0.46	1.49	0.65	-	0.65	0.37	3.47	3.84	11.64
I-3	-"-	3	-	-	-	-	5.88	1.22	7.10	5.04	2.04	7.08	4.24	-	4.24	4.48	7.45	11.93	30.35
		3a					5.1	1.2	6.3	3.36	0.80	4.16	2.73	-	2.73	1.56	4.37	5.93	19.12
0-1	Ash without fertilization till 1976 /control/	1	-	-	-	-	1.62	0.07	1.69	2.97	1.34	4.31	2.05	-	2.05	3.30	9.18	12.48	20.53
		1a					0.8	0.0	0.8	0.91	0.19	1.10	0.64	-	0.64	1.03	2.96	3.99	6.53
0-2		2	-	-	-	-	3.22	0.57	3.79	2.67	3.08	5.75	1.91	-	1.91	3.66	10.16	13.82	25.27
		2a					3.7	0.3	3.0	0.92	0.35	1.27	0.22	-	0.22	0.09	2.85	2.94	7.43
0-3		3	-	-	-	-	6.68	1.38	8.06	3.73	1.84	5.37	4.95	-	4.95	4.48	6.21	10.69	29.07
		3a					1.3	1.1	5.4	2.24	0.66	2.90	2.59	-	2.59	1.69	2.84	4.33	15.22

Note:

"a" in the col. 3 denotes plots non-fertilized in 1977-80

Crops from experimental plots reduced to the amount of protein
Halemba

Table 7

No. of plot	Combinations of soils and fertilizers	No. of mixture	Crops reduced to the amount of protein [kg/ha]																
			1975	1976			1977			1978			1979			1980			Total for the period 1975–1980
				I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20cm of fertile soil + NPK	2	552	466	406	872	726	684	1410	394	313	707	609	456	1065	734	880	1614	6220
A-3	"	3	316	251	242	493	580	262	842	210	205	415	430	300	730	489	619	1108	3904
A-4	"	4	238	285	285	570	665	600	1265	445	230	675	412	352	764	460	654	1114	4626
B-2	Ash + 10 cm of fertile soil + NPK	2	368	303	163	466	573	429	1002	242	165	407	534	462	996	417	562	979	4218
B-3	"	3	313	247	120	367	452	379	831	346	172	518	328	254	582	374	382	756	3367
B-4	"	4	198	321	216	537	445	678	1123	274	272	546	374	364	738	444	671	1115	4257
C-2	Ash + 5 cm of fertile soil + NPK	2	214	248	123	371	516	543	1059	286	226	512	538	320	858	377	670	1047	4061
C-3	"	3	231	263	124	387	438	302	740	185	162	347	301	256	557	255	610	865	3127
C-4	"	4	88	126	131	257	442	410	852	289	342	631	462	360	822	511	498	1009	3659
D-1	Ash + bentonite + NPK	1	225	207	98	305	539	371	910	243	249	492	453	261	714	468	627	1095	3741
D-2	"	2	110	137	56	193	395	221	616	205	221	426	290	242	532	406	579	985	2862
D-3	"	3	246	154	80	234	439	289	728	135	207	342	286	182	468	349	451	800	2818
E-1	Ash + low moor peat + NPK	1	670	198	289	487	992	491	1483	426	178	604	517	222	739	395	623	1018	5001
E-2	"	2	193	215	104	319	716	381	1097	265	157	422	319	268	587	363	544	907	3525
E-3	"	3	205	160	77	237	433	318	751	173	204	377	445	344	789	277	565	842	3201

Table 7. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
F-1	Ash + high moor peat + NPK	1	237	278	86	364	828	258	1086	211	232	443	277	257	534	517	389	906	3570
F-2	"	2	15	21	31	52	509	244	753	290	127	417	337	263	600	293	472	765	2602
F-3	"	3	22	40	22	62	508	198	706	152	148	300	287	259	546	307	550	857	2493
G-1	Ash + farm manure + NPK	1	83	126	33	159	646	221	867	243	172	415	301	323	624	400	543	943	3091
G-2	"	2	12	50	41	91	574	314	888	211	163	374	307	313	620	267	732	999	2984
G-3	"	3	107	166	60	226	610	190	800	139	200	339	179	256	435	252	550	802	2797
H-1	Ash + N2PK	1	198	271	59	330	456	241	697	247	229	476	453	286	739	339	747	1086	3526
H-2	"	2	61	160	155	315	526	254	780	291	252	543	433	325	758	307	672	979	3436
H-3	"	3	149	345	224	569	413	255	668	195	223	418	398	281	679	207	575	782	3265
I-1	Ash + NPK	1	141	70	33	103	460	254	714	268	262	530	354	211	565	559	499	1058	3111
I-2	"	2	62	111	48	159	473	324	797	208	223	431	359	272	631	386	566	952	3032
I-3	"	3	296	163	60	223	357	265	622	108	190	298	326	144	470	356	539	895	2804
0-1	Ash without fertilization till 1976 /control/	1 1a	397	216	150	366	369 238	313 351	682 589	230	188	418	417	217 132	634	330 133	427	757	3254
0-2	"	2 2a	17	176	156	332	331 250	226	556 269	155 519	184	339	350	288 172	638	319 68	612	931	2813
0-3	"	3 3a	332	251	191	442	373 221	104 159	477 380	128	184	312	384	248 48	632	256 62	840	1096	3291
	Note: "a" in the column 3 denotes crops from non-fertilized plots in the period 1977-1980																		

Crops from experimental plots reduced to the amount of protein

Konin

Table 8

No. of plot	Combinations of soils and fertilizers	No. of mixture	Crops reduced to the amount of protein [kg/ha]																
			1975	1976			1977			1978			1979			1980			Total for the period 1975-1980
				I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	0	236	166	402	738	766	1504	478	448	926	344	0	344	554	846	1400	4576
A-3	"	3	0	328	160	488	757	758	1515	587	309	896	294	0	294	619	769	1388	4581
A-4	"	4	0	112	62	174	477	587	1064	181	228	1335	397	0	397	765	866	1631	4601
B-2	Ash + 10 cm of fertile soil + NPK	2	0	212	147	359	655	439	1094	385	452	837	347	0	347	736	847	1583	4220
B-3	"	3	0	225	159	384	570	597	1167	542	340	882	327	0	327	727	977	1704	4464
B-4	"	4	0	106	108	214	418	368	786	313	254	567	262	0	262	760	1284	2044	3873
C-2	Ash + 5 cm of fertile soil + NPK	2	0	167	125	292	525	416	941	313	304	617	243	0	243	604	549	1153	3246
C-3	"	3	0	198	129	327	561	438	999	392	329	721	239	0	239	443	768	1211	3497
C-4	"	4	0	62	114	176	425	319	744	388	294	682	297	0	297	658	712	1370	3269
D-1	Ash + tertiany sand + NPK	1	0	4	0	4	328	52	380	283	156	439	314	0	314	554	654	1208	2345
D-2	"	2	0	145	97	242	373	253	626	338	329	667	197	0	197	577	960	1537	3269
D-3	"	3	0	130	91	221	548	274	822	367	262	629	227	0	227	535	829	1364	3263
E-1	Ash + low moor peat + NPK	1	0	0	0	0	372	14	386	304	246	550	144	0	144	643	884	1527	2607
E-2	"	2	0	25	38	63	501	392	893	481	409	890	246	0	246	700	776	1476	3568
E-3	"	3	0	6	76	82	604	446	1050	410	342	752	426	0	426	568	685	1253	3563

Table 8. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
F-1	Ash + high moor peat + NPK	1	0	0	0	0	353	0	353	390	241	631	176	0	176	578	628	1206	2366
F-2	"	2	0	16	58	74	522	275	797	438	371	809	239	0	239	728	845	1573	3492
F-3	"	3	0	14	7	21	661	425	1086	330	274	504	324	0	324	731	704	1435	3470
G-1	Ash + farm manure + NPK	1	0	19	0	19	437	30	467	359	184	543	201	0	201	494	629	1123	2353
G-2	"	2	0	304	104	408	682	260	942	367	338	705	253	0	253	532	640	1172	3480
G-3	"	3	0	278	149	427	662	380	1042	451	374	825	248	0	248	476	592	1068	3610
H/K/-1	Ash + N2PK + green manure /corn/	1	0	0	0	0	558	0	558	253	149	402	144	0	144	453	589	1042	2146
H/K/-2	"	2	0	0	60	60	678	279	957	542	382	924	174	0	174	669	773	1442	3557
H/K/-3	"	3	0	0	2	2	627	444	1071	440	381	821	393	0	393	511	683	1194	3481
I-1	Ash + NPK	1	0	0	0	0	397	0	397	378	174	552	215	0	215	550	697	1247	2411
I-2	"	2	0	0	35	35	589	199	788	368	325	693	288	0	288	639	667	1306	3110
I-3	"	3	0	0	0	0	610	256	866	441	237	678	345	0	345	540	652	1192	3081
0-1	Ash without fertilization till 1976 /control/	1 1a	0	0	0	0	134 71	9	143	319 193	189	508	188	0	188	487	706	1193	2032
0-2	"	2 2a	0	0	0	0	254 186	72	326	254 58	270	524	161	0	161	533 11	826	1359	2370
0-3	"	3 3a	0	0	0	0	727 475	211 208	938	319 165	220	539	396	0	396	737 222	543	1280	3153

Note: "a" in the column 3 denotes crops from non-fertilized plots in the period 1977-1980

Assimilation of mineral parts by plants per 1 ha

Halemba

Table 9

No. of plots	Combinations of soils and fertilizers	No. of mixture	Assimilation of mineral parts per 1 ha [kg]																
			1975	1976			1977			1978			1979			1980			Total in 1975–1980
				I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	482	265	199	464	282	385	667	162	153	315	361	309	670	375	790	1165	3763
A-3	"	3	313	198	205	403	168	252	420	123	128	251	240	227	467	284	592	876	2730
A-4	"	4	163	126	151	277	268	437	705	211	145	356	264	325	589	244	679	923	3013
B-2	Ash + 10 cm of fertile soil + NPK	2	356	174	114	288	194	355	549	158	125	283	321	374	695	253	599	852	3023
B-3	"	3	238	160	119	279	147	273	420	112	81	193	199	200	399	236	412	648	2177
B-4	"	4	158	173	124	297	161	432	593	153	124	277	235	290	525	288	657	945	2795
C-2	Ash + 5 cm of fertile soil + NPK	2	167	155	72	227	175	315	490	150	113	263	326	225	551	206	665	871	2569
C-3	"	3	182	167	121	288	142	200	341	92	95	187	185	216	401	149	577	726	2126
C-4	"	4	79	88	82	170	160	266	426	164	154	318	261	258	519	358	609	967	2479
D-1	Ash + bentonite + NPK	1	159	118	67	185	185	308	493	158	136	294	260	229	489	277	471	748	2368
D-2	"	2	78	68	55	123	150	189	339	110	94	204	157	179	336	253	419	672	1752
D-3	"	3	153	84	60	144	156	227	383	82	95	177	164	156	320	155	500	655	1832

Table 9. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
E-1	Ash + low moor peat + NPK	1	375	114	140	254	406	571	977	140	121	261	260	181	441	258	587	845	3153
E-2	"	2	135	111	60	171	321	406	727	117	93	210	176	190	366	231	484	715	2324
E-3	"	3	126	92	52	144	198	276	474	107	105	212	228	217	445	193	629	822	2223
F-1	Ash + high moor peat + NPK	1	144	117	42	159	383	244	627	93	125	218	152	194	346	390	439	739	2233
F-2	"	2	23	12	27	34	211	175	386	144	68	212	203	162	365	158	428	586	1606
F-3	"	3	28	24	21	45	273	178	451	70	65	135	129	153	282	172	533	705	1646
G-1	Ash + farm manure + NPK	1	59	68	34	102	283	154	437	113	93	206	153	215	368	238	504	742	1914
G-2	"	2	13	30	34	64	266	141	407	127	81	208	150	203	353	169	496	665	1710
G-3	"	3	77	82	43	125	243	152	395	85	87	172	95	196	291	110	513	623	1683
H-1	Ash + N2PK	1	116	133	35	168	262	249	511	157	146	303	244	234	478	218	571	789	2365
H-2	"	2	68	78	143	221	267	292	559	176	126	302	246	260	506	201	677	878	2534
H-3	"	3	119	185	118	303	163	243	406	111	131	242	236	214	450	152	524	676	2196
I-1	Ash + NPK	1	166	40	30	70	151	186	337	154	116	270	217	187	404	312	454	766	2013
I-2	"	2	52	77	51	128	168	237	405	119	92	211	182	176	358	224	451	675	1829
I-3	"	3	227	108	58	166	122	211	333	9	74	173	179	125	304	156	535	691	1894
O-1	Ash without fertilization till 1976 /control/	1 1a	242	115	139	254	149 101	226 230	375 331	139	79	218	227	176 87	403	223 88	606	829	2321
C-2	"	2 2a	20	81	109	190	122 127	210 236	332 363	98	95	193	198	227 106	425	177 32	661	838	1998
C-3	"	3 3a	202	115	108	223	130 99	141 157	271 256	106	99	205	232	231 28	463	168 45	617	785	2149
	Note: "a" in the column 3 denotes plots non-fertilized in 1977-1980																		

Assimilation of mineral parts by plants per 1 ha

Konin

Table 10

No. of plot	Combinations of soils and fertilizers	No. of mix-ture	Assimilation of numeral parts per 1 ha [kg]																
			1975	1976			1977			1978			1979			1980			Total in 1975–1980
				I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A–2	Ash + 20 cm of fertile soil + NPK	2	0	167	118	285	366	468	834	197	257	354	213	0	213	265	791	1056	2742
A–3	"	3	0	189	92	281	419	431	850	201	194	395	164	0	164	307	771	1078	2768
A–4	"	4	0	71	40	111	296	296	592	107	167	274	184	0	184	288	817	1105	2266
B–2	Ash + 10 cm of fertile soil + NPK	2	0	130	90	220	414	313	727	186	223	409	177	0	177	361	830	1191	2724
B–3	"	3	0	143	101	244	340	423	763	209	270	479	164	0	164	401	928	1329	2979
B–4	"	4	0	58	59	117	255	261	516	171	262	433	128	0	128	391	1249	1640	2834
C–2	Ash + 5 cm of fertile soil + NPK	2	0	127	95	222	347	330	677	159	203	362	142	0	142	368	783	1151	2554
C–3	"	3	0	134	87	221	351	341	692	193	239	432	143	0	143	233	1111	1344	2832
C–4	"	4	0	34	63	97	225	225	450	172	195	367	136	0	136	392	457	849	1899
D–1	Ash + tertiary sand + NPK	1	0	2	0	2	162	32	194	153	137	290	135	0	135	239	1016	1255	1876
D–2	"	2	0	106	71	177	214	221	435	179	293	472	146	0	146	370	1273	1643	2743
D–3	"	3	0	84	59	143	272	268	540	146	202	348	154	0	154	271	1264	1535	2720
..	. .. .																		

Table 10. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
E-1	Ash + low moor peat + NPK	1	0	0	0	0	185	12	197	173	187	360	97	0	97	231	1244	1475	2129
E-2	"	2	0	15	23	38	343	367	710	263	340	603	163	0	163	423	1278	1701	3215
E-3	"	3	0	5	62	67	369	353	722	239	209	448	231	0	231	375	1068	1443	2911
F-1	Ash + high moor peat + NPK	1	0	0	0	0	191	0	191	244	144	388	109	0	109	218	801	1019	1707
F-2	"	2	0	12	44	56	348	254	602	219	286	505	141	0	141	392	1224	1616	2920
F-3	"	3	0	16	8	24	408	279	687	217	217	434	207	0	207	402	1027	1429	2781
G-1	Ash + farm manure + NPK	1	0	12	0	12	265	31	296	277	155	432	121	0	121	291	940	1231	2092
G-2	"	2	0	217	74	291	526	278	804	257	338	595	186	0	186	330	905	1235	3111
G-3	"	3	0	187	100	287	532	340	872	281	312	593	179	0	179	280	800	1080	3011
H/K/-1	Ash + 2NPK + green manure with corn	1	0	0	0	0	279	0	279	227	103	330	89	0	89	231	809	1040	1738
H/K/-2	"	2	0	0	43	43	412	279	691	280	275	555	143	0	143	362	1066	1428	2860
H/K/-3	"	3	0	0	2	2	489	311	800	303	244	547	272	0	272	326	906	1232	2853
I-1	Ash + NPK	1	0	0	0	0	230	0	230	234	116	350	151	0	151	296	986	1282	2013
I-2	"	2	0	0	25	25	442	186	628	223	282	505	188	0	188	376	1020	1396	1584
I-3	"	3	0	0	0	0	388	126	514	318	202	520	265	0	265	348	895	1243	2542
O-1	Ash without fertilizer till 1976 /control/	1 1a	0	0	0	0	86 47	7 0	93 47	167 50	128	295	120	0	120	240	984	1224	1732
O-2	"	2 2a	0	0	0	0	195 149	59 31	254 180	161 53	252	413	115	0	115	296 7	1182	1478	2260
O-3	"	3 3a	0	0	0	0	600 378	151 113	751 491	275 133	197	472	285	0	285	371 137	679	1050	2558
	Note: "a" in the column 3 denotes plots nonfertilized in the period 1977–1980																		

Assimilation of calcium /CaO/ by plants [kg/ha]

Halemba

Table 11

No. of plot	Combinations of soils and fertilizers	No. of mixture	Assimilation of CaO per 1 ha /kg/																
			1975	1976			1977			1978			1979			1980			Total in 1975–1980
				I	II	total	I	II	total	I	II	total	I	II	total	I	II	total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	64	39	37	76	35	63	98	25	18	43	33	20	53	27	37	64	398
A-3	"	3	25	19	21	40	24	33	57	17	14	31	20	18	38	21	25	46	237
A-4	"	4	32	29	29	58	34	74	108	36	12	48	22	21	43	16	20	36	325
B-2	Ash + 10 cm of fertile soil + NPK	2	38	31	17	48	28	48	76	27	17	44	22	15	37	14	28	42	285
B-3	"	3	30	20	11	31	23	36	59	21	9	30	20	18	38	13	15	28	216
B-4	"	4	24	23	21	44	21	63	84	29	12	41	29	24	53	22	28	50	296
C-2	Ash + 5 cm of fertile soil + NPK	2	29	26	12	38	27	41	68	26	9	35	24	18	42	20	22	42	254
C-3	"	3	22	23	12	35	21	25	46	13	8	21	13	18	31	14	25	39	194
C-4	"	4	11	12	19	31	26	50	76	35	29	64	35	40	75	34	26	60	317
D-1	Ash + bentonite + NPK	1	21	14	13	27	26	25	51	18	10	28	14	19	33	21	38	59	219
D-2	"	2	7	10	8	18	20	15	35	25	14	39	32	17	49	38	18	56	204
D-3	"	3	18	11	6	17	18	21	39	8	8	16	11	13	24	12	25	37	151

Table 11. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
E-1	Ash + low moor peat + NPK	1	67	17	36	53	104	94	198	35	12	47	31	21	52	15	30	45	462
E-2	"	2	24	34	11	45	79	55	134	18	9	27	20	19	39	12	27	39	308
E-3	"	3	21	19	10	29	26	32	58	16	10	26	23	18	41	11	29	40	215
F-1	Ash + high moor peat + NPK	1	50	41	12	53	67	50	117	18	11	29	19	18	37	20	51	71	357
F-2	"	2	2	3	4	7	44	30	74	26	8	34	20	15	35	12	41	53	205
F-3	"	3	3	4	2	6	35	26	61	11	7	18	21	18	39	13	48	61	188
G-1	Ash + farm manure + NPK	1	10	16	4	20	47	27	74	20	9	29	16	23	39	13	52	65	237
G-2	"	2	1	4	5	9	39	21	60	14	10	24	14	18	32	13	71	84	210
G-3	"	3	9	17	6	23	36	20	56	13	10	23	9	15	24	8	40	48	183
H-1	Ash + N2PK	1	28	35	8	43	27	31	58	34	11	45	27	20	47	23	51	74	295
H-2	"	2	10	19	23	42	38	30	68	39	17	56	36	32	68	14	53	67	311
H-3	"	3	19	37	27	64	25	30	55	15	10	25	20	18	38	6	42	48	249
I-1	Ash + NPK	1	14	6	4	10	26	23	49	26	18	44	17	15	32	27	28	55	204
I-2		2	9	12	7	19	25	31	56	20	9	29	21	17	38	23	24	47	198
I-3		3	39	13	7	20	16	22	38	8	8	16	17	11	28	11	46	57	198
O-1	Ash without fertilization till 1976 /control	1 1a	54	27	20	47	22 22	32 44	54 66	26	8	34	23	22 22	45	13 15	47	60	294
O-2	"	2 2a	3	21	25	46	23 19	30 33	53 52	15	12	27	23	29 37	52	15 7	46	61	242
O-3	"	3 3a	38	24	22	46	19 12	16 18	35 30	10	9	19	21	20 10	41	9 5	55	64	243
	Note: "a" in the column 3 denotes plots non-fertilized in 1977-1980																		

Assimilation of calcium /CaO/ by plants [kg/ha]

Konin

Table 12

No. of plot	Combinations of soils and fertilizers	No. of mix-ture	Assimilation of CaO per 1 ha /kg/																
			1975	1976			1977			1978			1979			1980			Total in 1975–1980
				I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	I cut	II cut	total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	0	30	21	51	51	65	116	41	31	72	24	0	24	43	42	85	348
A-3	"	3	0	29	14	43	48	88	136	36	29	65	24	0	24	41	45	86	354
A-4	"	4	0	20	11	31	62	60	122	16	27	43	30	0	30	45	107	152	378
B-2	Ash + 10 cm of fertile soil + NPK	2	0	18	12	30	53	47	100	31	30	61	21	0	21	44	29	73	285
B-3	"	3	0	28	20	48	47	57	104	36	35	71	21	0	21	38	136	174	418
B-4	"	4	0	16	17	33	53	42	95	31	39	70	20	0	20	45	163	208	426
C-2	Ash + 5 cm of fertile soil + NPK	2	0	10	8	18	43	45	88	26	25	51	18	0	18	32	69	101	276
C-3	"	3	0	24	16	40	39	48	87	31	32	63	19	0	19	26	139	165	374
C-4	"	4	0	.9	17	26	67	34	101	33	24	57	23	0	23	19	109	128	335
D-1	Ash + tertiary sand + NPK	1	0	0	0	0	31	6	37	28	18	46	23	0	23	30	163	193	299
D-2	"	2	0	12	8	20	29	33	62	24	35	59	20	0	20	33	149	182	343
D-3	"	3	0	9	7	16	37	38	75	23	26	49	15	0	15	23	173	196	351
E-1	Ash + low moor peat + NPK	1	0	0	0	0	38	1	39	35	25	60	16	0	16	50	52	102	217
E-2	"	2	0	4	5	9	52	42	94	47	38	85	22	0	22	39	50	89	299
E-3	"	3	0	1	14	15	86	64	148	45	32	77	25	0	25	35	64	99	364

Table 12. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
F-1	Ash + high moor peat + NPK	1	0	0	0	0	35	0	35	55	24	79	23	0	23	34	46	80	217
F-2	"	2	0	2	7	9	57	36	93	32	36	68	15	0	15	32	58	90	275
F-3	"	3	0	3	1	4	108	59	167	37	35	72	26	0	26	35	48	83	352
G-1	Ash + farm manure + NPK	1	0	2	0	2	48	3	51	43	19	62	13	0	13	24	50	74	202
G-2	"	2	0	27	9	36	64	31	95	27	35	62	20	0	20	27	35	62	275
G-3	"	3	0	38	20	58	93	64	157	31	38	69	17	0	17	23	32	55	356
H/K/-1	Ash + N2PK + green manure /corn/	1	0	0	0	0	57	0	57	50	14	64	19	0	19	31	57	88	228
H/K/-2	"	2	0	0	10	10	83	32	115	34	36	70	17	0	17	31	46	77	289
H/K/-3	"	3	0	0	0	0	140	55	195	52	29	81	28	0	28	26	46	72	376
I-1	Ash + NPK	1	0	0	0	0	47	0	47	48	19	67	17	0	17	28	45	73	204
I-2	"	2	0	0	6	6	78	26	104	27	39	66	21	0	21	36	58	94	291
I-3	"	3	0	0	0	0	110	37	147	59	27	86	31	0	31	36	57	93	357
O-1	Ash without fertilization till 1976 /control/	1 1a	0	0	0	0	16 9	2 0	18 9	23 8	17	40	12	0	12	28 7	149	177	247
O-2	"	2 2a	0	0	0	0	44 30	2 1	46 31	20 7	31	51	12	0	12	27	163	190	299
O-3	"	3 3a	0	0	0	0	174 111	38 32	222 143	62 35	22	84	33	0	33	39 38	44	83	422

Note: "a" in the column 3 denotes plots non-fertilized in 1977-1980

Nitrogen management

Halemba

Table 13

No. of plot	Combinations of soils and fertilizers	No. of mixture	Degree of nitrogen fertilizers utilization [kg/ha]																							
			1975 a/ Fertilization 140/20 kg/ha		1976 Fertilization 150 kg/ha N				1977 Fertilization 200 kg/ha N				1978 Fertilization 200 kg/ha N				1979 Fertilization 270 kg/ha N				1980 Fertilization 270 kg/ha N				Loss of N with crops in 1975-1980	Difference between fertilization and loss
			Loss of N with crop	Difference between fertilization and crop	Loss of N with crop			Difference between fertilization and loss	Lose of N with crop			Difference between fertilization and loss	Loss of N with crop			Difference between fertilization and loss	Loss of N with crop			Difference between fertilization and loss	Loss of N with crop			Difference between fertilization and loss		
					I cut	II cut	total		I cut	II cut	total						I cut	II cut	total		I cut	II cut	total			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
A-2	Ash + 20 cm of fertile soil + NPK	2	88	52	75	65	140	10	116	110	226	-26	63	50	113	87	97	73	170	100	117	141	258	12	995	235
A-3	"	3	51	89	40	39	79	71	93	42	135	65	34	33	67	133	69	48	117	153	78	99	177	93	626	604
A-4	"	4	38	102	46	46	92	58	106	96	202	- 2	71	37	108	92	66	56	122	148	74	105	179	91	741	489
B-2	Ash + 10 cm of fertile soil + NPK	2	59	81	48	26	74	76	92	69	161	39	39	26	65	135	85	74	159	111	67	90	157	113	675	555
B-3	"	3	50	90	39	19	58	92	72	61	133	67	55	27	82	118	52	41	93	177	61	61	122	148	538	692
B-4	"	4	32	108	51	35	86	64	71	108	179	21	44	44	88	112	60	58	118	152	71	107	178	92	681	549
C-2	Ash + 5 cm of fertile soil + NPK	2	34	106	40	20	60	90	83	87	170	30	46	36	82	118	86	51	137	133	60	107	167	103	650	580
C-3	"	3	37	103	42	20	62	88	70	48	118	82	30	26	56	144	48	41	89	181	41	98	139	131	501	729
C-4	"	4	14	126	20	21	41	109	71	66	137	63	46	55	101	99	74	58	132	138	82	80	162	118	587	643
D-1	Ash + bentonite + NPK	1	36	104	33	16	49	101	86	59	145	55	39	40	79	121	73	42	115	155	75	100	175	95	599	631

Table 13. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
D-1	Ash + bentonite + NPK	1	36	104	33	16	49	101	86	59	145	55	39	40	79	121	73	42	115	155	75	100	175	95	599	631
D-2	"	2	18	122	22	9	31	119	63	35	98	102	33	35	68	132	46	39	85	185	66	93	159	111	459	771
D-3	"	3	39	101	25	13	38	112	70	46	116	84	22	33	55	145	46	29	75	195	56	72	128	142	451	779
E-1	Ash + low moor peat + NPK	1	107	37	32	46	78	72	159	79	238	-38	68	28	96	104	83	35	118	152	63	100	163	107	800	430
E-2	"	2	31	109	34	17	51	99	115	61	176	24	42	25	67	133	51	43	94	176	58	87	145	115	564	666
E-3	"	3	33	107	27	12	39	111	69	51	120	80	28	33	61	139	71	55	126	144	44	90	134	136	513	717
F-1	Ash + high moor peat + NPK	1	38	102	44	14	58	92	132	66	198	2	34	37	71	129	44	41	85	185	83	62	145	115	595	635
F-2	"	2	2	138	3	5	8	142	81	39	120	80	48	20	68	132	54	42	96	174	47	76	123	147	417	813
F-3	"	3	4	136	6	4	10	140	81	32	113	87	24	24	48	152	46	41	87	183	49	88	137	133	399	831
G-1	Ash + farm manure + NPK	1	13	127	20	5	25	125	103	35	138	62	39	28	67	133	48	52	100	170	64	87	151	119	494	736
G-2	"	2	2	138	8	7	15	135	92	29	121	79	34	26	60	140	49	50	99	171	43	117	160	110	457	773
G-3	"	3	17	123	27	10	37	113	98	30	128	72	22	32	54	146	29	41	70	200	40	88	128	142	434	796
H-1	Ash + N2PK	1	32	108	43	9	52	98	73	39	112	88	40	37	77	123	73	46	119	151	54	75	129	141	521	709
H-2	"	2	10	130	26	25	51	99	84	41	125	75	47	40	87	117	69	52	121	149	49	107	156	114	550	680
H-3	"	3	24	116	55	36	91	59	66	41	107	93	31	36	67	133	64	45	109	161	33	92	125	145	523	707
I-1	Ash + NPK	1	23	117	11	5	16	134	74	41	115	85	43	42	85	115	65	34	99	171	89	80	169	101	507	723
I-2	"	2	10	130	18	8	26	124	76	52	128	72	33	36	69	131	57	44	101	169	62	91	153	117	487	743
I-3	"	3	47	93	26	10	36	114	57	42	99	101	17	30	47	153	52	23	75	195	57	86	143	127	447	783
0-1	Ash without fertilization till 1976/control/	1 1b	63	-43	35	24	59	91	59 38	50 56	109 94	91 -94	37	30	67	133	67	35 21	102	168	53 21	68	121	149	521	569
0-2	"	2 2b	3	17	28	25	53	97	53 40	36 43	89 83	111 -83	25	30	55	145	56	46 28	102	168	51 11	98	149	121	451	639
0-3	"	3 3b	53	-33	40	30	70	80	60 35	16 25	76 60	124 -60	21	29	50	150	61	40 50	101	169	41 10	84	125	145	475	615

Note:

a/ Fertilization 20 kg/ha N on the combination 0 Fertilization 140 kg/ha N on the remaining combinations

b/ Plots without fertilization in 1977-1980

Nitrogen management

Konin

Table 14

No. of plot	Combinations of soils and cultures	No. of mixture	degree of nitrogen fertilizers utilization [kg/ha]																							Difference between fertilization and loss
			1975a/ Fertilization with N 155/34a/ 60 kg/ha		1976 Fertilization with N 150 kg/ha				1977 Fertilization with N 200 kg/ha				1978 Fertilization with N 200 kg/ha				1979 Fertilization with N 270 kg/ha				1980 Fertilization with N 270 kg/ha				loss of N in the years: 1975–1980	
			Loss of N with crop	Difference between fertilization and crops	Loss of N with crop			Difference between fertilization and crops	Loss of N with crop			Difference between fertilization and crops	Loss of N with crop			Difference between fertilization and crops	Loss of N with crop			Difference between fertilization and crops	Loss of N with crop			Difference between fertilization and crops		
					I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
A-2	Ash + 20 cm of fertile soil + NPK	2	10	155	38	26	64	86	118	123	241	-41	77	72	149	51	55	0	55	215	89	135	224	46	743	502
A-3	"	3	0	155	53	26	79	71	121	121	242	-42	94	49	143	57	47	0	47	223	99	123	222	48	763	482
A-4	"	4	0	155	18	10	28	122	76	94	170	30	29	36	65	135	64	0	64	206	122	139	261	9	588	657
B-2	Ash + 10 cm of fertile soil + NPK	2	0	155	34	24	58	92	105	70	175	25	62	72	134	66	55	0	55	215	118	135	253	17	675	570
B-3	"	3	0	155	36	25	61	89	91	95	186	14	87	54	141	59	52	0	52	218	116	156	272	- 2	712	533
B-4	"	4	0	155	17	17	34	116	67	59	126	74	50	41	91	109	42	0	42	228	122	206	328	-58	621	624
C-2	Ash + 5 cm of fertile soil + NPK	2	0	155	27	20	47	103	84	67	151	49	50	49	99	101	39	0	39	231	97	88	185	85	521	724
C-3	"	3	0	155	32	21	53	97	90	70	160	40	63	53	116	84	38	0	38	232	71	123	194	76	561	684
C-4	"	4	0	155	10	18	28	122	68	51	119	81	62	47	109	91	47	0	47	223	105	114	219	51	522	723
..	. .. .																									

Table 14. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
D-1	Ash + tertiary sand + NPK	1	0	155	1	0	1	149	52	8	60	140	45	25	70	130	50	0	50	220	89	105	194	76	375	870
D-2	"	2	0	155	23	15	38	112	60	41	101	99	54	53	107	93	32	0	32	238	92	154	246	24	524	721
D-3	"	3	0	155	21	15	36	114	88	44	132	68	59	42	101	99	36	0	36	234	86	133	219	51	524	721
E-1	Ash + low moor peat + NPK	1	0	155	0	0	0	150	60	2	62	138	49	39	88	112	23	0	23	247	103	141	244	26	417	828
E-2	"	2	0	155	4	6	10	140	80	63	143	57	77	65	142	58	39	0	39	231	112	124	236	34	570	675
E-3	"	3	0	155	1	12	13	137	97	71	168	32	66	55	121	79	68	0	68	202	91	110	201	69	571	674
F-1	Ash + high moor peat + NPK	1	0	155	0	0	0	150	56	0	56	144	62	39	101	99	28	0	28	242	92	101	193	77	378	867
F-2	"	2	0	155	3	9	12	138	83	44	127	73	70	54	124	76	38	0	38	222	116	135	251	19	552	693
F-3	"	3	0	155	2	1	3	147	106	68	174	26	53	44	97	103	52	0	52	218	117	113	230	40	556	689
G-1	Ash + farm manure + NPK	1	0	155	3	0	3	147	70	5	75	125	58	29	87	113	32	0	32	238	79	101	180	90	377	868
G-2	"	2	0	155	49	17	66	84	109	42	151	49	59	54	113	87	40	0	40	230	85	102	187	83	557	688
G-3	"	3	0	155	44	24	68	82	106	61	167	33	72	60	132	68	40	0	40	230	76	95	171	99	578	667
H/K/-1	Ash + N2PK + green manure /corn/	1	0	340	0	0	0	150	89	0	89	111	40	24	64	136	23	0	23	247	73	94	167	103	343	1087
H/K/-2	"	2	0	340	0	10	10	140	108	45	153	47	87	61	148	52	28	0	28	242	107	124	231	39	570	860
H/K/-3	"	3	0	340	0	0	0	150	100	71	171	29	70	61	131	69	63	0	63	207	82	109	191	79	556	874
I-1	Ash + NPK	1	0	155	0	0	0	150	64	0	64	136	61	28	89	111	34	0	34	236	88	112	200	70	387	858
I-2	"	2	0	155	0	6	6	144	94	32	126	74	59	52	111	89	46	0	46	224	102	107	209	61	498	747
I-3	"	3	0	155	0	0	0	150	98	41	139	61	71	38	109	91	55	0	55	215	86	104	190	80	493	752

Table 14. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
0-1	Ash without fertilization till 1976 /control/	1 1b	0	60 0	0	0	0	150	21 11	0 0	21 11	179 -11	51 9	30	81	119	30	0	30	240	78	113	191	79	323	827
0-2	"	2 2b	0	60 0	0	0	0	150	41 30	0 0	41 30	159 -30	41 9	43	84	116	26	0	26	244	85 2	132	217	53	368	782
0-3	"	3 3b	0	60 0	0	0	0	150	116 76	34 33	150 109	50 -109	51 26	35	86	114	63	0	63	207	118 35	87	205	65	504	646

Note:

a/Fertilization 155 kg/ha N on plots of the combinations A,B,C,D,E,F,G,I

Fertilization 340 hg/ha N on plots of the combination H

Fertilization 60 kg/ha N on plots of the combination O

Fertilization 0 kg/ha N on plots of the combination O without fertilizors

b/ Plots non-fertilized in 1977-1980

Potassium management [K_2O]

Halemba

Table 15

No. of plot	Combinations of soils and fertilizers	No. of mixture	Degree of potassium fertilizers utilization [kg/ha]																							Difference between fertilization and loss [kg/ha]
			1975a/ Fertilization K_2O 30 kg/ha		1976 non-fertilized				1977 non-fertilized				1978 not-fertilized				1979 Fertilized with K_2O 400 kg/ha				1980 Fertilized with K_2O 380 kg/ha				Loss of K_2O with crop in 1975-1980	
			loss of K_2O with crop	Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and loss		
					I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
A-2	Ash + 20 cm of fertile soil + NPK	2	114	-84	92	42	134	-134	63	73	136	-136	34	20	54	-54	114	89	203	197	165	291	456	-76	1097	-287
A-3	-"-	3	99	-69	68	56	124	-124	44	48	92	- 92	32	20	52	-52	89	60	149	251	130	232	362	18	878	- 68
A-4	-"-	4	42	-12	39	41	80	- 80	84	107	191	-191	45	17	62	-62	95	56	151	249	113	273	386	- 6	912	-102
B-2	Ash + 10 cm of fertile soil + NPK	2	90	-60	61	30	91	- 91	74	81	155	-155	37	16	53	-53	105	43	148	252	119	227	346	34	883	- 73
B-3	-"-	3	60	-30	57	32	89	-89	45	57	102	-102	26	12	38	-38	73	39	112	288	99	153	252	128	653	157
B-4	-"-	4	35	- 5	52	28	80	-80	46	112	158	-158	42	34	76	-76	78	55	133	267	118	227	345	35	827	- 17
C-2	Ash + 5 cm of fertile soil + NPK	2	41	-11	41	20	61	-61	62	80	142	-142	47	19	66	-66	112	51	163	237	83	256	339	41	812	- 2
C-3		3	51	-21	55	26	81	-81	48	47	95	- 95	29	22	51	-51	78	42	130	270	64	207	271	109	679	131
C-4		4	22	8	23	22	45	-45	55	85	140	-140	59	46	105	-105	96	58	154	246	143	184	327	53	793	17
D-1	Ash + bentonite + NPK	1	44	-14	42	19	61	-61	78	123	201	-201	60	43	103	-103	98	64	162	238	118	194	312	68	883	- 73
D-2	-"-	2	21	9	29	10	39	-39	67	70	137	-137	44	24	68	- 68	44	42	86	314	88	159	247	133	598	212
D-3	-"-	3	47	-17	33	18	51	-51	73	76	149	-149	32	27	59	- 59	60	34	94	306	64	196	260	120	660	160
E-1	Ash + low moor peat + NPK	1	88	-58	32	33	65	-65	103	99	202	-202	27	16	43	- 43	93	32	125	275	90	223	313	67	836	- 26
E-2	-"-	2	35	- 5	30	18	48	-48	85	96	181	-181	38	15	53	- 53	62	23	85	315	56	198	254	126	656	154
E-3	-"-	3	37	- 7	28	14	42	-42	60	65	125	-125	35	19	54	- 54	81	38	119	281	64	215	279	101	656	154
F-1	Ash + high moor peat + NPK	1	28	2	37	9	46	-46	79	64	143	-143	31	22	53	- 53	51	46	97	303	82	156	238	142	605	205
F-2	-"-	2	3	27	7	5	12	-12	66	47	113	-113	43	12	55	- 55	74	20	94	306	56	150	206	174	483	327

Table 15. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
F-3	Ash + high moor peat + NPK	3	4	26	8	4	12	-12	67	48	115	-115	24	15	39	-39	45	23	68	332	51	186	237	143	475	335
G-1	Ash + farm manure + NPK	1	10	20	18	5	23	-23	68	41	109	-109	40	17	57	-57	63	43	106	294	79	190	269	111	574	236
G-2	-"-	2	3	27	11	10	21	-21	89	43	132	-132	44	18	62	-62	47	28	75	325	41	176	217	163	510	300
G-3	-"-	3	19	11	27	11	38	-38	76	45	121	-121	28	22	50	-50	33	36	69	331	37	191	228	152	525	285
H-1	Ash + N2PK	1	28	2	39	7	46	-46	52	74	126	-126	48	28	76	-76	97	54	151	249	77	237	314	66	741	69
H-2	-"-	2	10	20	24	19	43	-43	69	86	155	-155	51	34	85	-85	84	51	135	265	81	298	379	1	807	3
H-3	-"-	3	20	10	66	32	98	-98	48	64	112	-112	35	30	65	-65	86	46	132	268	45	214	259	121	686	124
I-1	Ash + NPK	1	23	7	11	10	21	-21	48	58	106	-106	45	31	76	-76	88	54	142	258	120	159	279	101	647	163
I-2	-"-	2	11	19	18	9	27	-27	55	53	108	-108	40	27	67	-67	57	29	86	314	88	162	250	130	549	261
I-3	-"-	3	39	-9	37	13	50	-50	40	57	97	- 97	25	19	44	-44	65	26	91	309	58	215	273	107	594	216
O-1	Ash without fertilization till 1976 /control/	1 b/	43	-43	30	16	46	-46	36 23	57 64	93 87	- 93 - 87	36	14	50	-50	94	28 17	122	278	90 24	237	327	53	681	99
O-2	-"-	2 b/	-3	- 3	24	21	45	-45	40 39	55 58	95 97	- 95 - 97	37	24	61	-61	72	33 14	105	295	72 84	263	335	45	644	136
O-3	-"-	3 b/	42	-42	37	26	63	-63	48 35	28 29	76 64	- 76 -64	34	25	59	-59	93	42 2	135	265	59 9	202	265	119	636	144

Note: a/ Fertilization 30 kg/ha of K_2O on combinations A-I

Combination O without fertilization

b/ plots non-fertilized in 1977-80

Potassium management [K_2O]

Konin

Table 16

No. of plot	Combinations of soils and fertilizers	No. of mixture	Degree of potassium fertilizers' utilization [kg/ha]																							Difference between fertilization and loss of K_2O [kg/ha]
			1975 a/ Fertilization with K_2O 30 kg/ha		1976 nonfertilized				1977 nonfertilized				1978 nonfertilized				1979 Fertilized with K_2O 400 kg/ha				1980 Fertilized with K_2O 380 kg/ha				loss of K_2O with crops in 1975–1980	
			loss of K_2O with crop	Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and crop	loss of K_2O with crop			Difference between fertilization and loss		
					I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
A-2	Ash + 20cm of fertile soil + NPK	2	0	30	68	48	116	-116	164	143	307	-307	74	46	120	-120	68	0	68	+332	97	269	366	14	977	-167
A-3	"	3	0	30	67	33	100	-100	199	114	313	-313	68	48	116	-116	49	0	49	+351	131	237	368	12	946	-136
A-4	"	4	0	30	21	12	33	- 33	126	88	214	-214	42	35	77	- 77	54	0	54	346	119	212	331	49	709	101
B-2	Ash + 10cm of fertile soil + NPK	2	0	30	55	38	93	- 93	153	68	221	-221	89	35	124	-124	55	0	55	345	130	257	387	- 7	880	-70
B-3	"	3	0	30	56	39	95	- 95	143	135	278	-278	82	45	127	-127	45	0	45	355	171	306	477	-97	1022	-212
B-4	"	4	0	30	17	17	34	- 34	91	80	171	-171	60	43	103	-103	41	0	41	359	158	327	485	-105	834	- 24
C-2	Ash + 5 cm of fertile soil + NPK	2	0	30	49	37	86	- 86	132	85	217	-217	50	45	95	- 95	43	0	43	357	158	185	343	37	784	26
C-3	"	3	0	30	51	33	84	- 84	142	85	227	-227	58	32	90	- 90	43	0	43	357	103	276	379	1	772	38
C-4	"	4	0	30	10	18	28	- 28	64	55	119	-119	55	28	83	- 83	37	0	37	363	154	175	329	51	596	214
D-1	Ash + tertiary sand + NPK	1	0	30	1	0	1	- 1	71	8	79	- 79	52	23	75	- 75	44	0	44	356	100	267	367	13	566	244
D-2	"	2	0	30	34	23	57	- 57	99	60	159	-159	52	36	88	- 88	43	0	43	357	153	290	443	- 63	790	20
D-3	"	3	0	30	33	23	56	- 56	111	75	186	-186	44	26	70	- 70	50	0	50	350	120	345	465	- 85	827	- 17

Table 16. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
E-1	Ash + low moor peat + NPK	1	0	30	0	0	0	0	75	4	79	- 79	63	33	96	- 96	27	0	27	373	97	262	359	21	561	249
E-2	"	2	0	30	4	7	11	- 11	123	121	244	-244	88	46	136	-136	49	0	49	351	198	255	453	- 73	893	- 83
E-3	"	3	0	30	1	18	19	- 19	139	121	260	-260	79	55	134	-134	79	0	79	321	176	275	451	- 71	943	-133
F-1	Ash + high moor peat + NPK	1	0	30	0	0	0	0	85	0	85	- 85	96	31	127	-127	34	0	34	366	106	200	306	74	552	258
F-2	"	2	0	30	3	12	15	- 15	146	89	235	-235	93	57	150	-150	47	0	47	353	178	280	458	- 78	905	- 95
F-3	"	3	0	30	4	2	6	- 6	139	99	238	-238	89	57	146	-146	65	0	65	335	188	302	490	-110	945	-135
G-1	Ash + farm manure + NPK	1	0	30	5	0	5	- 5	109	11	120	-120	116	40	156	-156	43	0	43	357	125	243	368	12	692	118
G-2	"	2	0	30	97	33	130	-130	187	94	281	-281	123	84	207	-207	62	0	62	338	139	243	382	- 2	1062	-252
G-3	"	3	0	30	74	40	114	-114	232	111	343	-343	132	93	225	-225	63	0	63	337	135	243	378	2	1123	-313
H/K/-1	Ash + N2PK + green manure /corn/	1	0	30	0	0	0	0	118	0	118	-118	94	25	119	-119	25	0	25	375	106	182	288	92	550	260
H/K/-2	"	2	0	30	0	18	18	- 18	170	101	271	-271	127	56	183	-183	33	0	33	367	166	260	426	- 46	931	-121
H/K/-3	"	3	0	30	0	1	1	- 1	159	123	282	-282	119	77	196	-196	93	0	93	307	156	287	443	- 63	1015	-205
I-1	Ash + NPK	1	0	30	0	0	0	0	85	0	85	- 85	95	32	127	-127	52	0	52	348	134	240	374	6	638	172
I-2	"	2	0	30	0	11	11	- 11	176	61	237	-237	94	55	149	-149	65	0	65	335	173	255	428	- 48	890	- 80
I-3	"	3	0	30	0	0	0	0	114	45	159	-159	132	62	194	-194	78	0	78	322	171	245	416	- 36	847	- 37
0-1	Ash without fertilization till 1976 /control/	1 1b	0	0	0	0	0	0	36 16	2 0	38 16	- 38 - 16	68 21	32	100	-100	39	0	39	361	98	286	384	- 4	561	219
0-2	"	2 2b	0	0	0	0	0	0	60 53	17 11	77 64	- 77 - 64	62 18	39	101	-101	42	0	42	358	140 3	297	437	- 57	657	123
0-3	"	3 3b	0	0	0	0	0	0	187 123	42 41	229 164	-229 -164	109 51	59	168	-168	99	0	99	301	167 32	190	357	23	853	- 73

Note:

a/ Fertilization 30 kg/ha of K_2O on combinations A-1
Combination 0 withont fertilization

b/ Plots non-fertilized in 1977-80

P_2O_5 management

Halemba

Table 17

No. of plot	Combinations of soils and fertilizers	No. of mixture	Degree of P_2O_5 fertilizers' utilization [kg/ha]																							Difference between fertilization and loss
			1975 a/ Fertilization 210/350 kg/ha		1976 Fertilization 110 kg/ha				1977 Fertilization 120 kg/ha				1978 Fertilization 120 kg/ha				1979 Fertilization 120 kg/ha				1980 Fertilization 120 kg/ha				Total loss of P_2O_5 with crops in 1975–1980	
			Loss of P_2O_5 with crops	Difference between fertilization and loss	Loss of P_2O_5 with crops			Difference between fertilization and loss	Loss of P_2O_5 with crops			Difference between fertilization and loss	Loss of P_2O_5 with crops			Difference between fertilization and loss	Loss of P_2O_5 with crops			Difference between fertilization and loss	Loss of P_2O_5 with crops			Difference between fertilization and loss		
					I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
A-2	Ash + 20 cm of fertile soil + NPK	2	21	189	21	18	39	71	28	38	66	54	20	17	37	83	32	23	55	65	32	70	102	18	320	480
A-3	"	3	15	195	16	13	29	81	21	23	44	76	13	12	25	95	19	16	35	85	25	49	74	46	222	578
A-4	"	4	8	202	13	12	25	85	26	40	66	54	25	10	35	85	17	24	41	79	21	53	74	46	249	551
B-2	Ash + 10 cm of fertile soil + NPK	2	18	192	14	8	22	88	22	32	54	66	18	10	28	92	19	29	48	72	21	57	78	42	248	552
B-3	"	3	13	197	16	8	24	86	17	24	41	79	13	7	20	100	15	16	31	89	15	38	53	67	182	618
B-4	"	4	7	203	16	7	23	87	17	40	57	63	15	10	25	95	18	21	39	81	20	60	80	40	231	569
C-2	Ash + 5 cm of fertile soil + NPK	2	8	202	10	6	16	94	19	33	52	68	16	9	25	95	22	14	36	84	13	60	73	47	210	590
C-3	"	3	10	200	13	6	19	91	13	17	30	90	9	9	18	102	14	16	30	90	9	48	57	63	164	636
C-4	"	4	4	206	8	5	13	97	10	20	30	90	12	10	22	98	18	15	33	87	21	38	59	61	161	639

Table 17. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
D-1	Ash + bentanite + NPK	1	9	201	10	4	14	96	18	23	41	79	12	10	22	98	16	16	32	88	18	36	54	66	172	628
D-2	"	2	5	205	6	2	8	102	14	13	27	93	6	7	13	107	8	13	21	99	15	39	54	66	128	672
D-3	"	3	8	202	6	4	10	100	11	16	27	93	6	7	13	107	11	10	21	99	10	48	58	62	137	663
E-1	Ash + low moor peat + NPK	1	28	182	9	12	21	89	43	37	80	40	17	8	25	95	24	13	37	83	18	50	68	52	259	541
E-2	"	2	8	202	8	5	13	97	30	27	57	63	11	7	18	102	16	16	32	88	17	46	63	57	191	609
E-3	"	3	9	201	8	4	12	98	17	21	38	82	10	9	19	101	20	19	39	81	11	54	65	55	182	618
F-1	Ash + high moor peat + NPK	1	7	203	9	3	12	98	28	18	46	74	11	8	19	101	18	14	32	88	17	36	53	67	169	631
F-2	"	2	1	209	1	1	2	108	21	12	33	87	10	3	13	107	16	13	29	91	12	45	57	63	135	665
F-3	"	3	1	209	2	1	3	107	18	12	30	90	4	4	8	112	10	13	23	97	10	45	55	65	120	680
G-1	Ash + farm manure + NPK	1	2	208	4	2	6	104	21	12	33	87	4	5	9	111	10	15	25	98	14	39	53	67	128	672
G-2	"	2	1	209	2	2	4	106	25	12	37	83	6	5	11	109	9	16	25	95	10	40	50	70	128	672
G-3	"	3	4	206	7	3	10	100	26	12	38	82	6	7	13	107	6	16	22	98	8	43	51	69	138	662
H-1	Ash + N2PK	1	7	343	10	2	12	98	17	19	36	84	10	8	18	102	18	18	36	84	13	52	65	55	174	766
H-2	"	2	3	347	5	7	12	98	19	19	38	82	12	7	19	101	15	20	35	85	14	48	62	58	169	771
H-3	"	3	5	345	15	9	24	86	15	17	32	88	9	8	17	103	14	16	30	90	8	41	49	71	157	783

Table 17. Continued

1	2	3	4	5	6	7	8	9	10.	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
I-1	Ash + NPK	1	5	205	3	2	5	105	12	16	28	92	10	8	18	102	13	11	24	96	16	40	56	64	136	664
I-2	"	2	2	208	4	2	6	104	14	17	31	89	6	7	13	107	12	15	27	93	14	42	56	64	135	665
I-3	"	3	11	199	7	3	10	100	10	17	27	93	5	6	11	109	12	9	21	99	10	49	59	61	139	661
0-1	Ash without fertilization till 1976 /control/	1 1b	13	-13	8	6	14	96	12 8	21 20	33	87	14	6	20	100	14	11 5	25	95	14 5	41	55	65	160	430
0-2	"	2 2b	1	- 1	6	6	12	98	10 11	16 20	26	94	6	6	12	108	16	18 5	34	86	11 3	51	62	58	147	443
0-3	"	3 3b	12	-12	10	8	18	92	12 12	9 10	21	99	8	6	14	106	15	17 1	32	88	9 3	45	54	66	151	439

Note:

a/ Fertilization 210 kg/ha on combinations A,B,C,D,E,F,G,I,
Fertilization 350 kg/ha on combination H,
Combination 0 without fertilization

b/ Plots withont fertilization in 1977-1980

In col. 3 figures denote cultivation of:

1-lucerne with sweetclover
2-grasses mixed with legumes
3-lucerne with archard grass
4-sweetclover

P_2O_5 management

Konin

Table 18

No. of plot	Combinations of soils and fertilizers	No. of mixture	Degree of P_2O_5 fertilizers' utilization [kg/ha]																							Difference between fertilization and loss
			1975 Fertilization 370/670/90kg/ha		1976 Fertilization 110 kg/ha				1977 Fertilization 120 kg/ha				1978 Fertilization 120 kg/ha				1979 Fertilization 120 kg/ha				1980 Fertilization 120 kg/ha				Total loss of P_2O_5 with crops in 1975–1980	
			loss of P_2O_5 with crops	Difference between fertilization and loss	loss of P_2O_5 with crops			Difference between fertilization and loss	loss of P_2O_5 with crops			Difference between fertilization and loss	loss of P_2O_5 with crops			Difference between fertilization and loss	loss of P_2O_5 with crops			Difference between fertilization and loss	loss of P_2O_5 with crops			Difference between fertilization and loss		
					I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total		I cut	II cut	total			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
A-2	Ash + 20 cm of fertile soil + NPK	2	0	370	12	8	20	90	48	51	99	21	30	26	56	64	21	0	21	99	32	61	93	27	289	671
A-3	"	3	0	370	13	6	19	91	53	52	105	15	34	17	51	69	15	0	15	105	30	58	88	32	278	682
A-4	"	4	0	370	5	3	8	102	30	38	68	52	12	14	26	94	15	0	15	105	33	60	93	27	210	750
B-2	Ash + 10 cm of fertile soil + NPK	2	0	370	8	6	14	96	36	34	70	50	24	23	47	73	16	0	16	104	41	66	107	13	254	706
B-3	"	3	0	370	7	5	12	98	38	39	77	43	25	20	45	75	14	0	14	106	38	75	113	7	261	699
B-4	"	4	0	370	3	3	6	104	25	27	50	70	16	15	31	89	11	0	11	109	33	94	127	- 7	225	735
C-2	Ash + 5 cm of fertile soil + NPK	2	0	370	7	5	12	98	38	28	66	54	19	14	33	87	13	0	13	107	30	49	79	41	203	757
C-3	"	3	0	370	7	4	11	99	30	30	60	120	20	17	37	83	10	0	10	110	24	55	79	41	197	763
C-4	"	4	0	370	2	4	6	104	16	19	35	85	15	12	27	93	11	0	11	109	25	41	66	54	145	815

Table 18. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
D-1	Ash + tertiary sand + NPK	1	0	370	0	0	0	110	14	3	17	103	13	8	21	99	10	0	10	110	18	43	61	59	109	851
D-2	"	2	0	370	6	4	10	100	17	15	32	88	12	17	29	91	9	0	9	111	27	59	86	34	166	794
D-3	"	3	0	370	6	4	10	100	22	15	37	83	13	13	26	94	10	0	10	110	18	66	84	36	167	793
E-1	Ash + low moor peat + NPK	1	0	370	0	0	0	110	14	1	15	105	13	10	23	97	6	0	6	114	20	59	79	41	123	837
E-2	"	2	0	370	1	1	2	108	18	28	46	74	18	18	36	84	8	0	8	112	29	67	96	24	188	772
E-3	"	3	0	370	0	3	3	107	20	25	45	75	20	12	32	88	14	0	14	106	23	50	73	47	167	793
F-1	Ash + high moor peat + NPK	1	0	370	0	0	0	110	17	0	17	103	15	8	23	97	7	0	7	113	21	37	58	62	105	855
F-2	"	2	0	370	1	2	3	107	17	21	38	82	13	13	26	94	8	0	8	112	28	52	80	40	155	805
F-3	"	3	0	370	1	0	1	109	22	20	42	78	16	11	27	93	9	0	9	111	29	49	78	42	157	803
G-1	Ash + farm manure + NPK	1	0	370	1	0	1	109	27	2	29	91	14	8	22	98	6	0	6	114	23	39	62	58	120	840
G-2	"	2	0	370	13	5	18	92	31	21	52	68	15	18	33	87	10	0	10	110	29	49	78	42	191	769
G-3	"	3	0	370	8	5	13	97	31	25	56	64	22	16	38	82	10	0	10	110	21	40	61	59	178	782

Table 18. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
H/K/-1	Ash + N2PK + green manure /corn/	1	0	670	0	0	0	110	24	0	24	96	13	6	19	101	4	0	4	116	16	47	63	57	110	1150
H/K/-2	"	2	0	670	0	2	2	108	31	19	50	70	16	15	31	89	7	0	7	113	22	45	67	53	157	1103
H/K/-3	"	3	0	670	0	0	0	110	19	22	41	79	16	13	29	91	15	0	15	105	18	49	67	53	152	1108
I-1	Ash + NPK	1	0	370	0	0	0	110	23	0	23	97	7	6	13	107	8	0	8	112	26	43	69	51	113	847
I-2	"	2	0	370	0	2	2	108	24	11	35	85	8	13	21	99	9	0	9	111	31	66	97	23	164	796
I-3	"	3	0	370	0	0	0	110	18	9	27	93	6	8	14	106	12	0	12	108	20	53	73	47	126	834
O-1	Ash without fertilization till 1976 /control/	1 1a	0	90	0	0	0	110	8 3	1	9	111	9 2	7	16	104	7	0	7	113	17	50	67	53	99	581
O-2	"	2 2a	0	90	0	0	0	110	10 7	5	10	110	7 2	14	21	99	7	0	7	113	22 1	55	77	43	115	565
O-3	"	3 3a	0	90	0	0	0	110	17 11	8 7	25	95	4 3	8	12	108	14	0	14	106	29 7	35	64	56	115	565

Note:

a/ Figures in col.3 denote cultivation of:

1-sainfoin and crown vetch
2-grasses with legumes
3-lucerne with archard grass
4-sweetclover

b/ Fertilization 370 kg/ha of P_2O_5 on combinations A,B,C,D,E,F,G,I
Fertilization 670 kg/ha of P_2O_5 on combination H
Fertilization 90 kg/ha of P_2O_5 on combination O

Assimilation of boron by plants [g/ha]
Halemba

Table 19

No. of plot	Combinations of soils and fertilizers	No. of mixture	Assimilation of boron by plants																
			1975	1976			1977			1978			1979			1980			Total in 1975-1980
				I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	145	66	63	129	55	254	309	23	18	41	179	105	284	65	119	184	1092
A-3	"	3	89	44	33	77	38	6	44	22	13	35	104	62	166	57	88	145	556
A-4	"	4	75	53	70	123	52	19	71	37	18	55	99	87	186	39	98	137	647
B-2	Ash + 10 cm of fertile soil + NPK	2	56	50	33	83	33	10	43	43	71	114	160	105	265	40	104	144	705
B-3	"	3	85	36	19	55	41	5	46	30	10	40	129	54	183	35	81	116	525
B-4	"	4	57	57	54	111	39	17	56	40	13	53	106	95	201	49	111	160	638
C-2	Ash + 5 cm of fertile soil + NPK	2	47	44	26	70	49	9	58	50	12	62	156	80	236	43	93	136	609
C-3	"	3	49	49	20	69	47	6	53	24	13	37	77	81	158	27	86	113	479
C-4	"	4	27	33	49	82	53	15	68	75	50	125	165	106	271	43	199	242	815
D-1	Ash + bentonite + NPK	1	64	38	35	73	75	9	84	41	16	57	138	79	217	33	101	134	629
D-2	"	2	27	32	27	59	47	5	52	63	37	100	201	68	269	72	174	246	753
D-3	"	3	61	33	22	55	56	26	82	23	14	37	65	40	105	39	66	105	445
E-1	Ash + low moor peat + NPK	1	228	47	91	138	280	59	339	26	18	44	100	64	164	39	71	110	1023
E-2	"	2	59	57	21	78	106	62	168	21	12	33	73	59	132	36	85	121	591
E-3	"	3	48	39	21	60	68	28	96	18	16	34	118	91	209	32	118	150	597
F-1	Ash + high moor peat +NPK	1	99	69	33	102	200	81	281	16	13	29	61	67	128	52	80	132	771
F-2	"	2	4	6	11	17	134	48	182	32	17	49	121	51	172	34	80	114	538
F-3	"	3	7	8	6	14	125	33	158	15	11	26	105	66	171	37	78	115	492

Table 19. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
G_1	Ash + farm manure + NPK	1	28	33	11	44	152	34	186	35	20	55	96	70	166	22	71	93	572
G-2	"	2	3	9	13	22	96	17	113	31	20	51	84	72	156	37	113	150	495
G-3	"	3	30	36	14	50	112	17	129	16	11	27	46	53	99	25	79	104	469
H-1	Ash + N2PK	1	67	69	18	87	90	26	116	37	19	56	145	77	222	28	110	138	686
H-2	"	2	21	43	47	90	106	32	138	28	22	50	166	91	257	38	121	159	715
H-3	"	3	50	78	61	139	90	29	119	22	12	34	112	73	185	49	69	118	645
I-1	Ash + NPK	1	49	15	14	29	67	35	102	70	41	111	113	53	166	75	75	150	607
I-2	"	2	21	25	23	48	59	49	108	56	17	73	152	74	226	36	89	125	601
I-3	"	3	109	36	19	55	47	30	77	18	13	31	110	41	152	42	91	133	557
O-1	Ash without fertilization till 1976 (control)	0 b/	134	59	63	122	60 56	45 86	105 142	50	11	61	167	79 46	246	63 12	120	183	851
O-2	"	0 b/	5	46	46	92	74 46	47 36	121 82	23	23	46	114	73 63	187	14 6	84	98	549
O-3	"	0 b/	107	65	42	107	74 31	38 34	112 65	19	17	36	107	76 18	183	27 9	102	129	674

Note: a) Figures in col. 3 denote cultivation:
1 - lucerne with sweetclover
2 - mixtures of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover
b) Plots nonfertilized in 1977-1980

Assimilation of boron by plants [g/ha]
Konin

Table 20

No. of plot	Combinations of soils and fertilizers	No. of mix-ture a)	Assimilation of boron by plants																
			1975	1976			1977			1978			1979			1980			Total in 1975-1980
				I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	0	93	65	158	324	38	362	269	132	401	261	0	261	134	232	366	1706
A-3	"	3	0	107	52	159	310	37	347	339	110	449	215	0	215	152	256	408	1578
A-4	"	4	0	42	23	65	182	18	200	143	95	238	262	0	262	91	167	258	1023
B-2	Ash + 10 cm of fertile soil + NPK	2	0	120	83	203	434	261	695	313	45	358	321	0	321	241	215	456	2033
B-3	"	3	0	160	113	273	479	221	700	433	145	578	344	0	344	245	319	564	2459
B-4	"	4	0	55	55	110	255	22	277	252	164	416	244	0	244	147	293	440	1487
C-2	Ash + 5 cm of fertile soil + NPK	2	0	136	102	238	470	142	612	376	153	529	292	0	292	206	196	402	2073
C-3	"	3	0	151	98	249	434	283	717	491	242	733	353	0	353	144	287	431	2483
C-4	"	4	0	29	54	83	343	224	567	464	138	602	280	0	280	207	101	308	1840
D-1	Ash + tertiary sand + NPK	1	0	4	0	4	466	20	486	375	154	529	300	0	300	204	256	460	1779
D-2	"	2	0	125	83	208	586	206	792	354	265	619	316	0	316	203	274	477	2412
D-3	"	3	0	94	66	160	669	323	992	771	185	956	303	0	303	156	345	501	2912
E-1	Ash + low moor peat + NPK	1	0	0	0	0	547	13	560	539	370	809	295	0	295	438	293	731	2395
E-2	"	2	0	39	60	99	699	398	1097	975	396	1371	371	0	371	406	316	722	3660
E-3	"	3	0	8	107	115	700	444	1144	802	310	1112	461	0	461	358	261	619	3451
F-1	Ash + high moor peat +NPK	1	0	0	0	0	565	0	565	779	321	1100	326	0	326	246	404	650	2641
F-2	"	2	0	27	96	123	609	301	910	765	348	1113	307	0	307	289	566	855	3308
F-3	"	3	0	25	13	38	615	289	904	656	322	978	407	0	407	374	520	894	3221
..	. .. .																		

Table 20. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
G-1	Ash + farm manure + NPK	1	0	22	0	22	647	39	686	611	219	830	197	0	197	224	556	780	2515
G-2	"	2	0	404	138	542	1012	342	1354	834	325	1159	449	0	449	311	354	665	4169
G-3	"	3	0	293	157	450	894	438	1332	1061	363	1424	349	0	349	210	294	504	4059
H(K)-1	Ash + N2PK + green manure (corn)	1	0	0	0	0	1364	0	1364	597	218	815	282	0	282	323	331	654	3115
H(K)-2	"	2	0	0	73	73	561	326	687	917	387	1304	386	0	386	251	316	567	3017
H(K)-3	"	3	0	0	2	2	775	446	1221	1001	281	1282	582	0	582	307	495	802	3889
I-1	Ash + NPK	1	0	0	0	0	1243	0	1243	587	202	789	316	0	316	251	240	491	2839
I-2	"	2	0	0	42	42	486	267	753	735	263	998	352	0	352	254	299	553	2698
I-3	"	3	0	0	0	0	529	163	692	756	194	950	509	0	509	314	261	575	2726
0-1	Ash without fertilisation till 1976 (control)	1 b/	0	0	0	0	214 148	5 0	219 148	260 100	145	405	207	0	207	152	188	340	1171
0-2	"	2 b/	0	0	0	0	709 308	37 20	745 328	441 152	231	672	172	0	172	238 4	296	634	2223
0-3	"	3 b/	0	0	0	0	775 473	171 141	946 614	735 470	175	910	470	0	470	376 174	441	817	3143

Note: a) figures in the col. 3 denote cultivation of:
- 1 - sainfoin with crown vetch
- 2 - mixture of grasses and legumes
- 3 - lucerne with orchard grass
- 4 - sweetclover

b) plots nonfertilized in 1977-1980

Table 21

Assimilation of manganese by plants [g/ha]

Halemba

No. of plot	Combinations of soils and fertilizers	No. of mixture a)	Assimilation of manganese by plants																
			1975	1976			1977			1978			1979			1980			Total in 1975-1980
				I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	580	185	152	337	380	314	694	275	117	392	263	335	598	317	917	1234	3835
A-3	"	3	578	325	297	622	353	300	653	376	165	541	234	247	481	306	633	939	3814
A-4	"	4	103	46	78	124	487	534	1021	578	86	664	239	253	492	240	585	825	3229
B-2	Ash + 10 cm of fertile soil + NPK	2	282	87	80	167	378	442	820	345	117	462	208	243	451	250	505	755	2937
B-3	"	3	339	78	100	178	194	325	519	389	75	464	90	114	204	144	191	335	2039
B-4	"	4	121	105	43	148	144	251	395	190	64	254	162	231	393	147	319	366	1677
C-2	Ash + 5 cm of fertile soil + NPK	2	126	60	35	95	203	201	404	91	49	140	83	83	166	65	376	441	1372
C-3	"	3	149	70	85	155	111	113	224	47	33	80	66	122	188	53	216	269	1065
C-4	"	4	38	23	24	47	85	103	188	59	46	105	70	116	186	117	236	353	917
D-1	Ash + bentonite + NPK	2	72	31	19	50	95	113	208	75	58	133	114	56	170	99	130	229	862
D-2	"	3	35	15	44	59	79	81	160	48	37	85	55	61	116	96	139	235	690
D-3	"	4	62	18	22	40	63	98	161	47	37	84	60	62	122	55	149	204	673
E-1	Ash + low moor peat +NPK	1	140	32	34	66	173	363	536	58	46	104	106	53	159	109	226	335	1340
E-2	"	2	48	25	14	39	144	151	295	50	36	86	80	65	145	108	154	262	875
E-3	"	3	41	22	11	33	113	104	217	52	41	93	101	86	187	90	209	299	870
F-1	Ash + high moor peat + NPK	1	62	36	11	47	185	85	270	41	51	92	75	71	146	173	124	297	914
F-2	"	2	12	2	7	9	110	68	178	62	29	91	78	63	141	74	165	239	670
F-3	"	3	16	7	9	16	163	76	239	37	32	69	49.	64	113	82	236	318	771

Table 21. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
G-1	Ash + farm manure + NPK	1	28	18	16	34	156	56	212	41	49	90	45	74	119	97	225	322	805
G-2	"	2	7	9	11	20	179	62	241	48	39	87	57	64	121	74	158	232	708
G-3	"	3	32	20	12	32	128	74	202	31	37	68	38	80	118	59	192	251	703
H-1	Ash + N2PK	1	51	37	11	48	188	112	300	55	64	119	79	88	167	81	249	330	1015
H-2	"	2	28	22	19	41	164	124	288	46	53	99	79	98	177	86	322	408	1041
H-3	"	3	59	35	33	68	89	106	195	41	57	98	95	90	185	97	204	301	906
I-1	Ash + NPK	1	91	13	10	23	95	63	158	43	39	82	56	62	118	110	142	252	724
I-2	"	2	27	28	28	56	76	98	174	38	35	73	66	61	127	83	120	203	660
I-3	"	3	110	23	29	52	49	62	111	35	32	67	55	44	99	64	170	234	673
O-1	Ash without fertilization till 1976 (control)	1 b/	115	28	55	83	69 59	84 70	153 129	32	28	60	55	45 24	100	69 35	156	225	736
O-2	"	2 b/	10	17	41	58	57 65	84 85	141 149	27	36	63	67	96 39	163	62 11	220	282	717
O-3	"	3 b/	85	25	32	57	61 59	61 62	122 121	31	38	69	68	84 9	152	75 17	205	280	765

Note: a) Figures in col. 3 denote cultivation of:
- 1 - lucerne with sweetclover
- 2 - mixture of grasses with legumes
- 3 - lucerne with orchard grass
- 4 - sweetclover

b) Plots nonfertilized in 1977-1980

Table 22

Assimilation of manganese by plants [g/ha]
Konin

No. of plot	Combination of soils and fertilizers	No. of maxture a)	Assimilation of manganese by plants																
			1975	1976			1977			1978			1979			1980			Total in 1975-1980
				I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	0	109	77	186	274	356	630	233	258	491	157	0	157	158	457	615	2079
A-3	"	3	0	122	59	181	355	413	768	232	222	454	130	0	130	197	595	792	2325
A-4	"	4	0	40	22	62	210	197	407	88	166	254	122	0	122	174	438	612	1457
B-2	Ash + 10 cm of fertile soil + NPK	2	0	86	59	145	243	277	520	153	179	332	108	0	108	276	414	690	1795
B-3	"	3	0	95	67	162	282	345	627	245	280	525	125	0	125	176	565	741	2180
B-4	"	4	0	31	32	63	160	223	383	125	238	363	138	0	138	238	681	919	1866
C-2	Ash + 5 cm of fertile soil + NPK	2	0	85	64	149	224	283	507	129	164	293	104	0	104	255	449	704	1757
C-3	"	3	0	92	60	152	206	294	500	173	219	392	96	0	96	133	511	644	1784
C-4	"	4	0	16	29	45	114	142	256	122	185	307	101	0	101	151	114	265	974
D-1	Ash + tertiary sand + NPK	1	0	2	0	2	126	28	154	119	143	262	94	0	94	159	363	522	1034
D-2	"	2	0	151	101	252	197	192	389	132	328	460	102	0	102	270	625	895	2098
D-3	"	3	0	172	120	292	196	211	407	123	186	309	94	0	94	161	529	690	1792
E-1	Ash + low moor peat + NPK	1	0	0	0	0	130	7	137	134	111	245	68	0	68	211	529	740	1190
E-2	"	2	0	9	14	23	235	222	457	185	245	430	109	0	109	326	705	1031	2050
E-3	"	3	0	3	39	42	207	244	451	190	133	323	136	0	136	235	582	817	1769
F-1	Ash + high moor peat + NPK	1	0	0	0	0	146	0	146	152	115	267	82	0	82	161	481	642	1137
F-2	"	2	0	8	29	37	199	173	372	170	257	427	104	0	104	315	472	787	1727
F-3	"	3	0	9	5	14	171	139	310	164	123	287	121	0	121	213	373	586	1318

Table 22. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
G-1	Ash + farm manure + NPK	1	0	8	0	8	197	18	215	189	89	278	85	0	85	184	373	557	1143
G-2	"	2	0	149	51	200	392	161	553	177	205	382	90	0	90	199	416	615	1840
G-3	"	3	0	100	54	154	339	225	564	206	171	377	115	0	115	123	277	400	1610
H(K)-1	Ash + N2PK + green manure (corn)	1	0	0	0	0	184	0	184	128	63	191	50	0	50	121	287	408	833
H(K)-2	"	2	0	0	25	25	255	189	444	261	204	465	112	0	112	261	402	663	1709
H(K)-3	"	3	0	0	1	1	228	147	375	186	107	293	144	0	144	163	351	514	1327
I-1	Ash + NPK	1	0	0	0	0	142	0	142	119	64	183	79	0	79	176	408	584	988
I-2	"	2	0	0	15	15	251	135	386	137	233	370	113	0	113	284	475	759	1643
I-3	"	3	0	0	0	0	144	62	206	151	118	269	146	0	146	181	373	554	1175
O-1	Ash without fertilization till 1976 (control)	1 b/	0	0	0	0	69 38	5 0	74 38	94 24	84	178	82	0	82	66 193	436	629	963
O-2	"	2 b/	0	0	0	0	137 122	37 16	174 138	123 34	259	382	67	0	67	275 6	574	849	1472
O-3	"	3 b/	0	0	0	0	224 142	90 59	314 201	119 82	92	211	168	0	168	211 101	320	531	1224

Note: a) Figures in the col. 3 denote cultivation of:
1 - sainfoin with crown vetch
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover
b) Plots without fertilization in 1977-1980

Assimilation of zinc by plants [g/ha]

Halamba

Table 23

No. of plot	Combinations of soils and fertilizers	No. of mix-ture a)	Assimilation of zinc by plants																
			1975	1976			1977			1978			1979			1980			Total in 1975-1980
				I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	774	568	309	877	679	608	1287	851	285	1136	347	305	652	583	605	1188	5854
A-3	"	3	379	199	353	552	525	524	1049	517	172	689	423	201	624	375	424	799	4092
A-4	"	4	272	280	209	489	683	875	1558	794	159	953	386	189	575	377	429	806	4653
B-2	Ash + 10 cm of fertile soil + NPK	2	519	298	151	449	575	633	1208	591	120	711	454	249	703	386	408	794	4384
B-3		3	138	318	158	476	430	500	930	337	117	454	136	127	263	290	270	560	2821
B-4		4	217	304	122	426	262	503	765	445	124	569	250	231	481	215	330	545	3003
C-2	Ash + 5 cm of fertile soil + NPK	2	205	179	69	248	290	514	804	178	120	298	186	129	315	140	350	490	2360
C-3	"	3	475	274	146	420	199	268	467	109	61	170	122	135	257	79	279	358	2147
C-4	"	4	52	86	61	147	206	295	501	134	86	220	145	140	285	189	97	286	1491
D-1	Ash + bentonite + NPK	1	83	64	39	103	191	252	443	149	80	229	119	113	232	151	213	364	1454
D-2	"	2	4	32	30	62	141	187	328	94	65	159	73	98	171	160	182	342	1066
D-3	"	3	7	42	44	86	134	275	409	72	65	147	88	95	183	95	218	313	1145
E-1	Ash + low moor peat + NPK	1	137	58	78	136	325	528	853	154	58	212	175	78	253	172	234	406	1997
E-2	"	2	51	67	41	108	250	356	606	111	53	164	141	110	251	242	199	441	1621
E-3	"	3	57	55	35	90	152	272	424	101	72	173	151	125	276	141	268	409	1429
F-1	Ash + high moor peat + NPK	1	43	74	23	97	231	199	430	79	81	160	84	104	188	228	181	409	1327
F-2	"	2	1	1	12	13	171	148	319	127	44	171	117	85	202	129	207	336	1042
F-3	"	3	6	12	10	22	171	190	361	58	42	100	75	69	144	181	276	457	1090

Table 23. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
G-1	Ash + farm manure + NPK	1	19	36	17	53	213	142	355	91	69	160	76	120	196	150	216	366	1149
G-2	"	2	5	22	20	42	210	145	355	116	60	176	100	89	189	153	243	396	1163
G-3	"	3	27	44	28	72	200	156	356	78	54	132	59	90	149	98	230	328	1064
H-1	Ash + N2PK	1	37	70	18	88	321	229	550	104	56	160	137	84	221	116	231	347	1403
H-2	"	2	16	36	45	81	213	223	436	96	72	168	111	86	197	132	281	413	1311
H-3	"	3	31	82	54	136	167	222	389	72	83	155	129	100	229	160	214	374	1314
I-1	Ash + NPK	1	43	24	15	39	168	186	354	107	59	166	100	101	201	176	189	365	1168
I-2	"	2	17	36	21	57	149	181	330	80	56	136	112	117	229	124	212	336	1105
I-3	"	3	71	59	35	94	101	296	397	87	46	133	104	75	179	111	222	333	1207
O-1	Ash without fertilization till 1975 (control)	1 b/	85	52	60	112	129 93	206 182	335 275	87	45	132	101	89 32	190	137 71	206	343	1197
O-2	"	2 b/	5	38	50	88	112 98	191 200	303 298	54	44	98	134	76 30	210	102 19	227	329	1033
O-3	"	3 b/	72	56	67	123	125 74	134 127	259 201	75	50	125	109	84 11	193	154 35	239	393	1165

Note: a) Figures in col. 3 denote cultivation of:
1 - lucerne with sweetclover
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover
b) Plots nonfertilized in 1977-1980

Assimilation of zinc by plants [g/ha]
Konin

Table 24

No. of plot	Combinations of soils and fertilizers	No. of mixture a)	Assimilation of zinc by plants																
			1975	1976			1977			1978			1979			1980			Total in 1975-1980
				I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A-2	Ash + 20 cm of fertile soil + NPK	2	0	58	41	99	170	153	323	90	64	154	70	0	70	129	145	274	920
A-3	"	3	0	59	29	88	182	155	337	90	38	128	47	0	47	115	136	251	648
A-4	"	4	0	21	11	32	92	112	204	41	45	86	79	0	79	96	151	247	648
B-2	Ash + 10 cm of fertile soil + NPK	2	0	57	40	97	143	86	229	67	77	144	54	0	54	139	143	282	806
B-3	"	3	0	36	26	62	116	124	240	69	47	116	54	0	54	99	170	269	741
B-4	"	4	0	17	17	34	81	105	186	54	46	100	56	0	56	130	265	395	771
C-2	Ash + 5 cm of fertile soil + NPK	2	0	38	28	66	128	71	199	56	44	100	42	0	42	109	123	232	639
C-3	"	3	0	39	25	64	110	67	177	47	46	93	29	0	29	109	144	253	616
C-4	"	4	0	10	19	29	59	63	122	51	44	95	40	0	49	93	199	292	578
D-1	Ash + tertiary sand + NPK	1	0	0	0	0	49	7	56	34	22	56	27	0	27	69	160	129	268
D-2	"	2	0	2	13	15	67	39	106	32	47	79	38	0	38	97	159	256	494
D-3	"	3	0	16	11	27	66	37	103	39	31	70	26	0	26	49	151	200	426
E-1	Ash + low moor peat + NPK	1	0	0	0	0	51	2	53	31	22	53	25	0	25	294	178	472	603
E-2	"	2	0	3	3	6	54	68	122	53	43	96	37	0	37	91	192	283	544
E-3	"	3	0	0	7	7	80	75	155	51	24	75	43	0	43	65	152	217	497
F-1	Ash + high moor peat + NPK	1	0	0	0	0	58	0	58	41	19	60	21	0	21	58	121	179	318
F-2	"	2	0	2	6	8	63	54	117	45	39	84	32	0	32	109	169	278	519
F-3		3	0	2	1	3	65	57	122	48	25	73	55	0	55	79	121	200	453

Table 24. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
G-1	Ash + farm manure + NPK	1	0	3	0	3	82	5	87	45	27	72	31	0	31	87	139	226	419
G-2	"	2	0	55	19	74	174	45	219	63	45	108	39	0	39	83	116	199	639
G-3	"	3	0	42	23	67	112	72	184	61	36	97	42	0	42	53	118	171	561
H(K)-1	Ash + N2PK + green manure (corn)	1	0	0	0	0	82	0	82	48	15	63	18	0	18	63	136	199	362
H(K)-2	"	2	0	0	11	11	92	48	140	70	40	110	34	0	34	98	163	261	556
H(K)-3	"	3	0	0	0	0	83	52	135	58	30	88	54	0	54	81	176	257	534
I-1	Ash + NPK	1	0	0	0	0	59	0	59	48	13	61	36	0	36	80	142	222	378
I-2	"	2	0	0	6	6	95	32	127	46	32	78	32	0	32	98	172	270	513
I-3	"	3	0	0	0	0	74	33	107	50	21	71	54	0	54	67	144	211	443
O-1	Ash without fertilization till 1975 (control)	1 b/	0	0	0	0	19 16	2	21	30 11	19	49	21	0	21	25 76	161	237	328
O-2	"	2 b/	0	0	0	0	39 31	15	54	28 12	37	65	18	0	18	70 2	147	217	354
O-3	"	3 b/	0	0	0	0	84 58	32 27	116	39 27	22	61	51	0	51	81 36	118	199	427

Note: a) Figures in col. 3 denote cultivation of:
1 - sainfoin with crown vetch
2 - mixture of grasses and legumes
3 - lucerne with orchard grass
4 - sweetclover
b) Plots nonfertilized in 1977-1980

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Table 25. Continued

1	2	3	4	5	6	7	8	9	10	11
H-1	Ash + N2PK	1	2600	4680	7280			5580	39.8	
H-2	-"-	2	2430	5470	7900			4980	39.8	
H-3	-"-	3	2170	5230	7400			6830	36.5	
I-1	Ash + NPK	1	2190	4360	6550			4350	32.4	
I-2	-"-	2	2310	4070	6380			5380	33.6	
I-3	-"-	3	1940	4490	6430			5300	37.7	
O-1	Ash non-fertilized in 1975 /control/ - after reseeding in 1976	1	2050	3780	5830			4880	40.1	
O-2	-"-	2	2410	4470	6880			6200	36.6	
O-3	-"-	3	2480	5200	7680			6830	41.4	

Note: x/ in col. 3 figures denote predecessors:

1-purple medic
2-mix. of grasses with legumes
3-mix. of orchard grass with lucerne
4-white melilot

Yields of winter barley from experimental plots
on ash pile (1981)

KONIN

Table 26

No. of plot	Ash soil treatment for cultivation of predecessor in 1975	Type of prede-cessor x/	Crops of barley in conversion to kg/ha						Weight of 1000 grains /g/	
			from plots fertilized in 1976-1981			from plots non-fertilized in 1977-1980			from plots fertilized in 1976 - 1981	from plots non-fertili-zed in 1977-1980
			grain	straw	total	grain	straw	total		
1	2	3	4	5	6	7	8	9	10	11
A-2	Ash + 20 cm of fertile soil + NPK	2	3260	3790	7050	2910	3340	6250	30.1	32.8
A-3	-"-	3	2600	3130	5730	1310	1440	2750	24.4	28.7
A-4	-"-	4	2810	2920	5730	1990	1860	3850	33.4	34.4
B-2	Ash + 10 cm of fertile soil + NPK	2	2460	2670	5130			4000	31.4	
B-3	-"-	3	2480	2570	5050			4300	30.6	
B-4	-"-	4	2300	2480	4780			4580	31.3	
C-2	Ash + 5 cm of fertile soil + NPK	2	2690	2390	5080			4580	33.0	
C-3	-"-	3	2600	2600	5200			4100	33.6	
C-4	-"-	4	2170	2760	4930			4180	29.7	
D-1	Ash + tertiary sand + NPK	1	2130	2450	4580			3900	37.4	
D-2	-"-	2	2410	2290	4700			3530	34.5	
D-3	-"-	3	2160	2070	4230			3280	34.9	
E-1	Ash + low moor peat + NPK	1	1830	1720	3550			3000	34.0	
E-2	-"-	2	2210	2090	4300			2750	32.1	
E-3	-"-	3	2450	2250	4700			3450	38.9	
F-1	Ash + high moor peat + NPK	1	2850	2650	5500			3000	36.0	
F-2	-"-	2	1920	1730	3650			3000	32.7	
F-3	-"-	3	2110	2270	4380			3130	34.5	

Table. 26 Continued

1	2 2	3	4	5	6	7	8	9	10	11
G-1	Ash + farm manure + NPK	1	1840	2290	4130			3000	35.0	
G-2	-"-	2	1860	2120	3980			3800	34.1	
G-3	-"-	3	2650	2530	5180			4230	33.2	
H/K/-1	Ash + N2PK + green manure of maize	1	2120	2480	4600			3700	36.8	
H/K/-2	-"-	2	2260	2340	4600			2900	36.5	
H/K/-3	-"-	3	2670	2460	5130			3900	35.5	
I-1	Ash + NPK	1	2950	2980	5930			3080	36.3	
I-2	-"-	2	2480	2470	4950			3450	35.9	
I-3	-"-	3	3000	2430	5430			4280	36.1	
O-1	Ash nonfertilized in 1975-,after reseeding in 1976	1	2680	2400	5080			3000	35.5	
O-2	-"-	2	1340	1260	2600			1250	37.0	
O-3	-"-	3	2560	2620	5180			2380	39.4	

Note: x/ in col. 3 figures denote predecessors:

1-mix. of sainfoin with crown vetch
2-mix. of grasses with legumes
3-mix. of orchard grass with lucerne
4-white melilot

The content of macroelements in barley grains gathered from plots fertilized
in 1975 - 80

H A L E M B A

Table 27

No. of plot	Ash soil treatment	Type of predecessor a/	* Content in dry mass /%/							
			ash	N	P_2O_5	K_2O	CaO	MgO	Na_2O	S_{total}
1	2	3	4	5	6	7	8	9	10	11
A-2	Ash + 20 cm of fertile soil + NPK	2	2.56	1.89	0.78	0.64	0.07	0.20	0.001	0.09
		2b/	2.57	2.00	0.79	0.56	0.09	0.20	0.004	0.10
A-3	-"-	3	2.60	1.47	0.70	0.60	0.05	0.23	0.001	0.10
		3b/	2.66	1.82	0.78	0.62	0.07	0.18	0.001	0.10
A-4	-"-	4	2.88	1.58	0.79	0.63	0.08	0.29	0.001	0.09
		4b/	2.68	1.89	0.78	0.72	0.08	0.22	0.002	0.16
B-2	Ash + 10 cm of fertile soil + NPK	2	2.68	1.28	0.78	0.58	0.06	0.24	0.001	0.09
B-3	-"-	3	2.51	1.61	0.75	0.58	0.05	0.23	0.001	0.04
B-4	-"-	4	2.64	1.47	0.70	0.57	0.05	0.24	0.001	0.05
C-2	Ash + 5 cm of fertile soil + NPK	2	2.44	1.89	0.70	0.59	0.06	0.24	0.001	0.12
C-3	-"-	3	2.61	1.79	0.69	0.69	0.04	0.28	0.001	0.14
C-4	-"-	4	2.56	2.24	0.78	0.64	0.03	0.27	0.001	0.17
D-1	Ash + bentonite + NPK	1	2.56	1.93	0.75	0.60	0.03	0.24	0.001	0.06
D-2	-"-	2	2.69	1.86	0.79	0.64	0.05	0.22	0.001	0.13
D-3	-"-	3	2.68	1.82	0.79	0.71	0.04	0.30	0.001	0.14
E-1	Ash + low moor peat + NPK	1	2.79	1.33	0.85	0.67	0.03	0.20	0.001	0.08
E-2	-"-	2	2.46	1.54	0.79	0.68	0.08	0.18	0.001	0.10
E-3	-"-	3	2.69	1.65	0.88	0.64	0.04	0.18	0.001	0.16
F-1	Ash + high moor peat + NPK	1	.	.	.	.	.	.	.	.
F-2	-"-	2	2.44	1.84	0.83	0.68	0.05	0.28	0.001	0.08
F-3	-"-	3	2.36	1.75	0.75	0.62	0.08	0.27	0.001	0.10
G-1	Ash + farm manure + NPK	1	2.22	2.00	0.75	0.58	0.03	0.28	0.001	0.08
G-2	-"-	2	2.45	1.86	0.75	0.64	0.05	0.24	0.001	0.04
G-3	-"-	3	2.47	1.93	0.78	0.68	0.04	0.28	0.001	0.12

Table 27. Continued

1	2	3	4	5	6	7	8	9	10	11
H-1	Ash + N2PK	1	2.83	1.86	0.79	0.68	0.04	0.28	0.001	0.14
H-2	-"-	2	2.71	1.75	0.78	0.70	0.03	0.28	0.001	0.08
H-3	-"-	3	2.65	1.58	0.70	0.62	0.03	0.23	0.001	0.13
J-1	Ash + NPK	1	2.59	2.00	0.70	0.60	0.03	0.30	0.001	0.12
J-2	-"-	2	2.54	1.65	0.75	0.60	0.03	0.30	0.001	0.09
J-3	-"-	3	2.62	1.65	0.79	0.62	0.04	0.33	0.003	0.12
O-1	Ash nonfertilized in 1975	1	2.92	1.75	0.85	0.64	0.04	0.28	0.001	0.09
O-2	-"-	2	2.84	1.68	0.79	0.69	0.05	0.24	0.001	0.10
O-3	-"-	3	2.74	1.60	0.83	0.70	0.05	0.30	0.001	0.09

Notes:

a/ Predecessors in 1975-80

1 - lucerne
2 - mix of grasses with legumes
3 - mix of orchard grass with lucerne
4 - melitot

b/ plots non-fertilized in 1977-80

The content of macroelements in barley grains gathered from plots fertilized in 1975-1980

KONIN

Table 28

No. of plot	Ash soil treatment	Type of predecessor a/	Content in dry mass /%/							
			Ash	N	P_2O_5	K_2O	CaO	MgO	Na_2O	S total
1	2	3	4	5	6	7	8	9	10	11
A-2	Ash + 20 cm of fertile soil + NPK	2	2.65	1.80	0.79	0.56	0.11	0.13	0.002	0.13
		2b/	2.69	1.68	0.73	0.56	0.08	0.10	0.003	0.12
A-3	-"-	3	2.55	2.07	0.88	0.58	0.12	0.24	0.002	0.11
		3b/	2.69	1.82	0.79	0.54	0.10	0.10	0.004	0.11
A-4	-"-	4	2.92	1.80	0.70	0.58	0.10	0.14	0.002	0.16
		4b/	2.45	1.77	0.83	0.62	0.11	0.14	0.003	0.09
B-2	Ash + 10 cm of fertile soil + NPK	2	2.58	2.65	0.79	0.57	0.10	0.17	0.002	0.15
B-3	-"-	3	2.65	1.68	0.85	0.60	0.11	0.20	0.002	0.12
B-4	-"-	4	2.66	1.54	0.85	0.60	0.07	0.20	0.001	0.12
C-2	Ash + 5 cm of fertile soil + NPK	2	2.70	1.51	0.75	0.62	0.08	0.18	0.001	0.11
C-3	-"-	3	2.60	1.40	0.75	0.56	0.07	0.33	0.001	0.09
C-4	-"-	4	2.77	1.49	0.78	0.52	0.09	0.17	0.001	0.11
D-1	Ash + tertiary sand + NPK	1	2.59	1.54	0.70	0.51	0.08	0.20	0.001	0.16
D-2	-"-	2	2.60	1.58	0.75	0.54	0.07	0.14	0.001	0.11
D-3	-"-	3	2.73	1.56	0.70	0.51	0.07	0.20	0.001	0.11
E-1	Ash + low moor peat + NPK	1	3.11	1.58	0.71	0.52	0.07	0.20	0.001	0.08
E-2	-"-	2	2.68	1.75	0.70	0.54	0.08	0.20	0.001	0.10
E-3	-"-	3	2.80	1.56	0.66	0.56	0.07	0.18	0.002	0.09
F-1	Ash + high moor peat + NPK	1	2.90	1.60	0.65	0.56	0.07	0.14	0.002	0.12
F-2	-"-	2	2.79	1.61	0.66	0.56	0.08	0.17	0.001	0.09
F-3	-"-	3	2.55	1.75	0.63	0.50	0.07	0.18	0.001	0.06
G-1	Ash + farm manure + NPK	1	2.44	1.61	0.63	0.50	0.08	0.14	0.001	0.12
G-2	-"-	2	2.60	1.58	0.75	0.56	0.07	0.20	0.001	0.04
G-3	-"-	3	2.58	1.61	0.69	0.52	0.07	0.18	0.001	0.06
H/K/-1	Ash + N2PK + green manure	1.	3.04	1.58	0.65	0.51	0.05	0.17	0.001	0.11
H/K/-1	-"-	2	2.72	1.61	0.69	0.54	0.07	0.17	0.001	0.11
H/K/-1	-"-	3	2.85	1.40	0.63	0.50	0.07	0.14	0.001	0.03

Table 28. Continued

1	2	3	4	5	6	7	8	9	10	11
I-1	Ash + NPK	1	2.45	1.47	0.65	0.56	0.07	0.10	0.001	0.11
I-2	-"-	2	2.43	1.58	0.69	0.52	0.07	0.13	0.001	0.11
I-3	-"-	3	2.77	1.51	0.66	0.52	0.07	0.18	0.002	0.09
0-1	Ash without fertilization in 1975 1975	1	2.56	1.46	0.66	0.54	0.06	0.20	0.001	0.04
0-2	-"-	2	2.51	1.58	0.66	0.58	0.07	0.20	0.002	0.08
0-3	-"-	3	2.87	1.58	0.66	0.52	0.08	0.18	0.002	0.11

a/ Predecessors in 1975-80:

1 - mix of sainfoin with crown vetch
2 - mix of grasses with legumes
3 - mix of orchard grass with lucerne
4 - white melilot

b/ plots nonfertilized in 1975-1980

The content of microelements in barley grains gathered from plots fertilized in 1975–1980

HALEMBA

Table 29

No. of plot	Ash soil treatment	Type of predecessor a/	Content in dry mass /p.pm/						
			B	Cu	Mn	Mo	Zn	Co	Fe
1	2	3	4	5	6	7	8	9	10
A-2	Ash + 20 cm of fertile soil + NPK	2	2.10	3.50	15.5	0.62	67.0	0.38	131.5
		2b/	2.00	4.25	12.0	0.75	60.0	0.36	111.5
A-3	-"-	3	1.80	3.25	12.5	1.05	51.5	0.33	145.0
		3b/	2.00	5.00	16.0	0.46	80.0	0.42	138.0
A-4	-"-	4	2.40	3.25	12.2	1.22	66.0	0.40	142.0
		4b/	4.20	5.50	20.5	0.43	97.5	0.41	167.0
B-2	Ash + 10 cm of fertile soil + NPK	2	2.10	3.00	10.0	0.90	80.0	0.40	110.0
B-3	-"-	3	2.80	4.25	12.0	1.22	63.5	0.38	121.0
B-4	-"-	4	1.60	4.25	12.0	1.38	59.0	0.34	125.0
C-2	Ash + 5 cm of fertile soil + NPK	2	2.40	4.00	12.0	1.40	60.5	0.41	116.0
C-3	-"-	3	2.10	4.50	12.0	2.00	53.5	0.46	132.0
C-4	-"-	4	2.10	4.25	10.5	2.40	53.0	0.37	127.0
D-1	Ash + bentonite + NPK	1	3.00	4.70	11.5	2.05	47.5	0.42	136.0
D-2	-"-	2	2.10	4.70	12.0	2.17	54.0	0.48	132.0
D-3	-"-	3	1.80	4.75	10.5	1.90	37.5	0.38	114.5
E-1	Ash + low moor peat + NPK	1	1.40	4.75	9.0	2.25	30.5	0.42	99.5
E-2	-"-	2	1.80	4.75	9.0	1.52	28.0	0.38	80.0
E-3	-"-	3	1.80	5.50	9.0	1.45	35.0	0.37	108.5
F-1	Ash + high moor peat + NPK	1	.	.	.	.	.	.	.
F-2	-"-	2	2.10	5.50	10.5	1.88	37.0	0.37	97.5
F-3	-"-	3	1.80	5.25	9.0	1.82	32.5	0.34	125.0
G-1	Ash + farm manure + NPK	1	4.00	6.25	14.0	1.76	37.5	0.40	173.0
G-2	-"-	2	1.80	4.50	11.0	2.07	27.0	0.33	111.0
G-3	-"-	3	3.00	5.50	10.5	2.00	38.0	0.38	153.0
H-1	Ash + N2PK	1	2.40	5.00	14.0	2.07	36.5	0.45	140.5
H-2	-"-	2	2.00	5.00	14.5	1.95	36.0	0.38	100.0
H-3	-"-	3	2.60	5.00	14.0	1.63	32.0	0.54	107.5

Table 29. Continued

1	2	3	4	5	6	7	8	9	10
I-1	Ash + NPK	1	2.40	3.75	10.5	1.95	46.0	0.44	119.5
I-2	-"-	2	1.60	4.00	10.5	1.67	41.5	0.40	121.0
I-3	-"-	3	2.00	4.00	9.5	1.36	40.0	0.40	90.0
O-1	Ash non-fertilized in 1975	1	2.00	3.75	9.0	1.52	38.5	0.38	90.0
O-2	-"-	2	1.80	4.00	10.5	2.17	26.5	0.42	83.0
O-3	-"-	3	1.60	4.75	14.5	1.80	37.0	0.49	113.5

a/
Notes: Predecessors in 1975-80

1-lucerne
2-mix of grasses with legumes
3-mix of orchard grass with lucerne
4- white melilot

b/ plots non-fertilized in 1977-80

The content of microelements in barley grains gathered
from plots fertilized in 1975-1980

KONIN

Table 30

No. of plot	Ash soil treatment	Type of predecessor a/	Content in dry mass /ppm/						
			B	Cu	Mn	Mo	Zn	Co	Fe
1	2	3	4	5	6	7	8	9	10
A-2	Ash + 20 cm of fertile soil + NPK	2b/	5.00	4.25	15.7	0.87	24.5	0.34	79.5
		2	5.20	5.00	15.0	0.74	32.0	0.30	72.5
A-3	-"-	3b/	5.00	3.85	17.5	0.76	29.0	0.33	83.0
		3	6.00	6.50	16.7	0.68	27.0	0.36	93.0
A-4	-"-	4b/	6.80	4.00	16.0	0.74	27.5	0.38	86.5
		4	5.80	5.25	15.0	0.46	27.5	0.33	84.0
B-2	Ash + 10 cm of fertile soil + NPK	2	4.80	4.20	15.5	0.70	23.0	0.23	75.5
B-3	-"-	3	7.40	4.20	17.5	0.82	26.0	0.26	74.0
B-4	-"-	4	4.60	4.00	14.0	0.83	23.0	0.30	77.5
C-2	Ash + 5 cm of fertile soil + NPK	2	6.00	4.10	15.0	0.87	20.0	0.23	64.0
C-3	-"-	3	6.30	3.70	15.5	0.85	24.5	0.22	76.0
C-4	-"-	4	8.60	3.70	18.0	0.84	24.0	0.28	87.0
D-1	Ash + tertiary sand + NPK	1	6.70	3.00	16.0	1.22	24.2	0.27	78.0
D-2	-"-	2	8.20	3.45	13.5	0.91	35.0	0.23	78.0
D-3	-"-	3	7.60	3.45	12.0	0.95	28.5	0.28	67.0
E-1	Ash + low moor peat + NPK	1	6.50	3.50	15.5	1.16	25.2	0.36	64.0
E-2	-"-	2	7.75	3.20	17.0	1.06	28.2	0.30	59.0
E-3	-"-	3	6.25	3.25	15.2	1.22	23.0	0.24	50.0
F-1	Ash + high moor peat + NPK	1	7.80	2.50	18.0	1.28	25.5	0.30	73.0
F-2	-"-	2	9.00	3.20	15.5	1.17	23.2	0.22	57.0
F-3	-"-	3	7.80	3.50	19.0	1.50	23.7	0.28	83.0
G-1	Ash + farm manure + NPK	1	6.70	3.50	16.7	1.50	28.0	0.28	73.0
G-2	-"-	2	6.30	3.75	15.0	1.21	31.7	0.33	74.0
G-3	-"-	3	6.90	3.25	15.0	1.10	25.0	0.38	68.5
H/K/-1	Ash + N2PK + green manure	1	6.30	3.00	15.0	1.60	26.5	0.33	83.0
H/K/-2	-"-	2	4.00	3.10	14.0	1.17	24.5	0.45	76.0
H/K/-3	-"-	3	7.40	3.35	15.7	1.28	36.0	0.33	80.0

Table 30. Continued

1	2	3	4	5	6	7	8	9	10
J-1	Ash + NPK	1	5.80	3.00	15.0	1.25	29.5	0.32	84.0
J-2	-"-	2	6.00	3.10	16.0	1.17	21.5	0.30	89.5
J-3	-"-	3	7.80	3.50	15.0	1.60	23.5	0.30	78.5
O-1	Ash nonfertilized in 1975	1	6.70	3.80	15.5	1.50	26.5	0.32	61.5
O-2	-"-	2	8.60	3.80	16.0	1.17	31.0	0.32	82.0
O-3	-"-	3	6.20	3.20	16.5	1.53	23.7	0.36	87.0

Notes: a/ Predecessors in 1975-80:

1-mix of sainfoin with crown vetch
2-mix of grasses with legumes
3-mix of orchard grass with lucerne
4-white melilot

b/ plots nonfertilized in 1977-80

The content of macroelements in barley straw gathered from plots fertilized in 1975–1980

HALEMBA

Table 31

No. of plot	Ash soil treatment	Type of predecessor a/	Content in dry mass /%/							
			ash	N	P_2O_5	K_2O	CaO	MgO	Na_2O	S_{total}
1	2	3	4	5	6	7	8	9	10	11
A-2	Ash + 20 cm of fertile soil + NPK	2b/	4.54	0.67	0.18	1.42	0.41	0.22	0.043	0.06
		2	4.53	0.77	0.23	1.16	0.45	0.24	0.120	0.09
A-3	-"-	3b/	3.97	0.53	0.20	1.14	0.27	0.20	0.033	0.11
		3	4.59	0.88	0.36	1.48	0.42	0.18	0.055	0.12
		4b/	4.48	0.70	0.23	1.40	0.35	0.20	0.033	0.06
		4	4.80	0.79	0.21	1.18	0.35	0.18	0.103	0.19
B-2	Ash + 10 cm of fertile soil + NPK									
B-3	-"-	2	4.81	0.46	0.20	1.43	0.31	0.22	0.015	0.07
B-4	-"-	3	4.61	0.81	0.28	1.31	0.31	0.27	0.027	0.12
		4	4.13	0.76	0.23	1.08	0.42	0.24	0.057	0.15
C-2	Ash + 5 cm of fertile soil + + NPK									
C-3	-"-	2	4.79	1.05	0.36	1.41	0.38	0.30	0.046	0.12
C-4	-"-	3	5.24	0.98	0.49	1.40	0.33	0.34	0.036	0.15
		4	6.19	1.52	0.49	2.04	0.41	0.46	0.046	0.19
D-1	Ash + bentonite + NPK	1	5.82	0.95	0.41	1.92	0.29	0.33	0.037	0.02
D-2	-"-	2	5.40	1.02	0.31	1.93	0.34	0.43	0.043	0.15
D-3	-"-	3	4.72	1.02	0.36	1.61	0.32	0.42	0.042	0.16
E-1	Ash + low moor peat + NPK	1	5.43	0.70	0.31	2.40	0.41	0.23	0.023	0.10
E-2	-"-	2	5.12	1.02	0.31	2.34	0.53	0.28	0.039	0.16
E-3	-"-	3	5.69	0.84	0.31	2.42	0.52	0.28	0.038	0.16
F-1	Ash + high moor peat + NPK	1								
F-2	-"-	2	5.41	1.21	0.39	2.13	0.38	0.43	0.031	0.15
F-3	-"-	3	4.19	1.19	0.31	1.80	0.33	0.34	0.041	0.16
G-1	Ash + farm manure + NPK	1	4.53	1.37	0.36	1.90	0.27	0.42	0.042	0.16
G-2	-"-	2	4.67	1.19	0.36	1.96	0.25	0.43	0.022	0.11
G-3	-"-	3	4.90	1.33	0.39	1.91	0.38	0.43	0.037	0.16
H-1	Ash + N2PK	1	5.99	1.05	0.31	2.50	0.56	0.33	0.048	0.20
H-2	-"-	2	6.44	1.12	0.41	2.40	0.47	0.40	0.039	0.32
H-3.	-"-	3	4.93	0.88	0.23	1.84	0.41	0.32	0.042	0.15

Table 31. Continued

1	2	3	4	5	6	7	8	9	10	11
I-1	Ash + NPK	1	5.19	1.19	0.41	1.70	0.39	0.42	0.054	0.05
I-2	-"-	2	4.34	0.95	0.31	1.49	0.26	0.37	0.039	0.05
I-3	-"-	3	4.96	0.95	0.36	1.79	0.30	0.32	0.041	0.12
0-1	Ash nonfertilized in 1975	1	5.46	1.23	0.45	2.10	0.51	0.37	0.063	0.20
0-2	-"-	2	5.17	0.88	0.28	2.04	0.37	0.32	0.049	0.17
0-3	-"-	3	5.38	0.86	0.30	2.28	0.48	0.32	0.041	0.19

Notes:

a/ Predecessors in 1975-80:

1- lucerne
2- mix of grasses with legumes
3- mix of orchard grass with lucerne
4- melilot

b/ Plots nonfertilized in 1977-80

The content of macroelements in barley straw gathered from plots fertilized in 1975-80

KONIN

Table 32

No. of plot	Ash soil treatment		ash	N	P_2O_5	K_2O	CaO	MgO	Na_2O	S_{total}
1	2	3	4	5	6	7	8	9	10	11
A-2	Ash + 20 cm of fertile soil + NPK	2 b/	5.02	0.81	0.23	1.78	0.56	0.13	0.95	0.25
		2	5.14	0.84	0.20	1.46	0.61	0.18	0.114	0.31
A-3	-"-	3 b/	4.82	0.70	0.15	1.70	0.55	0.13	0.137	0.25
		3	5.16	0.84	0.20	1.34	0.64	0.20	0.135	0.27
A-4	-"-	4 b/	5.00	0.68	0.20	1.56	0.60	0.17	0.088	0.20
		4	4.97	0.74	0.20	1.50	0.52	0.20	0.096	0.41
B-2	Ash + 10 cm of fertile soil + NPK	2	5.18	0.81	0.23	1.76	0.59	0.20	0.064	0.21
B-3	-"-	3	5.09	0.58	0.20	1.62	0.54	0.20	0.132	0.16
B-4	-"-	4	5.33	0.70	0.23	1.88	0.51	0.13	0.068	0.36
C-2	Ash + 5 cm of fertile soil + NPK	2	5.33	0.56	0.16	2.03	0.46	0.17	0.047	0.28
C-3	-"-	3	6.07	0.60	0.20	2.06	0.42	0.22	0.043	0.21
C-4	-"-	4	4.78	0.88	0.16	1.66	0.51	0.22	0.097	0.27
D-1	Ash + tertiary sand + NPK	1	5.40	0.63	0.20	2.01	0.42	0.18	0.042	0.25
D-2	-"-	2	5.34	0.63	0.14	1.92	0.49	0.17	0.047	0.25
D-3	-"-	3	4.83	0.58	0.13	1.95	0.46	0.13	0.063	0.25
E-1	Ash + low moor peat + NPK	1	6.98	0.63	0.20	2.44	0.40	0.20	0.062	0.08
E-2	-"-	2	6.74	0.70	0.23	2.56	0.45	0.20	0.090	0.39
E-3	-"-	3	6.70	0.63	0.20	2.50	0.42	0.18	0.065	0.27
F-1	Ash + high moor peat + NPK	1	6.55	0.60	0.15	2.68	0.45	0.20	0.085	0.17
F-2	-"-	2	6.75	0.53	0.15	2.66	0.46	0.18	0.048	0.21
F-3	-"-	3	6.20	0.67	0.15	2.20	0.44	0.18	0.085	0.25
G-1	Ash + farm manure + NPK	1	6.12	0.76	0.23	2.25	0.40	0.21	0.047	0.27
G-2	-"-	2	6.48	0.60	0.20	2.51	0.47	0.20	0.051	0.22
G-3	-"-	3	6.16	0.63	0.20	2.42	0.41	0.14	0.038	0.27
H/K/-1	Ash + N2PK	1	6.25	0.60	0.25	2.60	0.41	0.13	0.057	0.21
H/K/-2	-"-	2	7.03	0.63	0.20	2.86	0.47	0.14	0.080	0.27
H/K/-3	-"-	3	6.55	0.53	0.13	2.34	0.50	0.14	0.050	0.19

Table 32. Continued

1	2	3	4	5	6	7	8	9	10	11
I-1	Ash + NPK	1	6.39	0.60	0.20	2.50	0.49	0.20	0.045	0.22
I-2	-"-	2	5.96	0.58	0.21	2.50	0.43	0.18	0.053	0.16
I-3	-"-	3	7.07	0.53	0.13	2.92	0.43	0.14	0.074	0.19
O-1	Ash nonfertilized in 1975	1	6.01	0.56	0.13	2.12	0.44	0.18	0.038	0.27
O-2	-"-	2	5.67	0.49	0.20	2.26	0.50	0.18	0.047	0.31
O-3	-"-	3	6.14	0.53	0.13	2.41	0.50	0.18	0.074	0.17

Notes:

a/ Predecessor in 1975-80:

1-mix of sainfoin with crown vetch
2-mix of grasses with legumes
3-mix of orchard grass with lucerne
4-melilot

b/ Plots nonfertilized in 1977-80

The content of microelements in barley straw gathered
from plots fertilized in 1975-80

HALEMBA

Table 33

No. of plot	Ash soil treatment	Type of predecessor a/	Content in dry mass /ppm /						
			B	Cu	Mn	Mo	Zn	Co	Fe
1	2	3	4	5	6	7	8	9	10
A-2	Ash + 20 cm of fertile soil + NPK	2	9.00	3.50	28.5	0.58	95.0	0.48	487.0
		2b/	10.50	3.85	19.0	0.52	78.5	0.46	440.0
A-3	-"-	3	7.75	3.60	16.5	0.92	67.5	0.56	380.0
		3b/	8.35	4.45	18.5	0.56	100.0	0.48	380.0
A-4	-"-	4	6.50	3.35	21.0	0.94	105.0	0.48	457.0
		4b/	6.50	4.70	25.0	0.46	130.0	0.42	457.0
B-2	Ash + 10 cm of fertile soil + NPK	2	7.75	2.50	17.0	0.72	68.7	0.48	430.0
B-3	-"-	3	7.75	3.35	16.0	0.96	100.0	0.45	400.0
B-4	-"-	4	10.00	3.50	15.0	1.38	106.0	0.49	390.0
C-2	Ash + 5 cm of fertile soil + NPK	2	10.00	4.35	19.0	1.44	58.7	0.48	440.0
C-3	-"-	3	12.00	4.20	15.0	2.59	50.2	0.55	320.0
C-4	-"-	4	12.50	4.95	16.0	2.80	60.0	0.54	420.0
D-1	Ash + bentonite + NPK	1	12.50	4.45	15.0	1.96	52.0	0.68	128.0
D-2	-"-	2	10.50	4.20	15.0	1.67	60.0	0.68	450.0
D-3	-"-	3	12.00	4.70	16.0	1.80	40.0	0.80	480.0
E-1	Ash + low moor peat + NPK	1	8.35	3.70	12.0	4.14	34.0	0.48	90.0
E-2	-"-	2	10.00	3.85	12.0	2.95	31.0	0.48	80.0
E-3	-"-	3	11.00	4.00	12.0	2.31	35.5	0.68	72.00
F-1	Ash + high moor peat + NPK	1	.	.	.	.	.	.	.
F-2	-"-	2	16.00	4.65	14.7	2.32	37.5	0.45	90.0
F-3	-"-	3	10.00	4.25	13.0	1.32	34.0	0.59	89.0
G-1	Ash + farm manure + NPK	1	8.35	4.90	15.0	1.38	40.5	0.43	109.0
G-2	-"-	2	11.00	4.10	14.0	2.35	33.5	0.52	93.0
G-3	-"-	3	10.50	4.50	14.5	2.11	38.5	0.54	104.5
H-1	Ash + N2PK	1	15.00	4.20	15.0	3.22	33.5	0.58	350.0
H-2	-"-	2	13.50	4.45	15.5	3.15	61.5	0.58	187.5
H-3	-"-	3	8.35	3.25	15.5	1.63	32.5	0.50	365.0

Table 33. Continued

1	2	3	4	5	6	7	8	9	10
I-1	Ash + NPK	1	19.00	4.20	15.5 1	1.67	39.5	0.56	450.0
I-2	-"-	2	12.50	4.00	16.0	1.32	42.5	0.52	460.0
I-3	-"-	3	10.00	3.70	14.0	1.67	33.5	0.50	345.0
O-1	Ash nonfertilized in 1975	1	16.75	4.50	15.0	2.69	37.5	0.63	430.0
O-2	-"-	2	11.00	3.60	13.7	2.55	48.7	0.50	330.0
O-3	-"-	3	11.50	4.00	13.5	2.71	27.5	0.58	63.0

Notes:

a/ Predecessors in 1975-80:

1-lucerne
2-mix of grasses with legumes
3-mix of orchard grass with lucerne
4-white melilot

b/ Plots nonfertilized in 1977-80

The content of microelements in barley straw gathered from plots fertilized in 1975-80

KONIN

Table 34

No of plots	Ash soil treatment	Type of predecessor a/	Content in dry mass /ppm/						
			B	Cu	Mn	Mo	Zu	Co	Fe
1	2	3	4	5	6	7	8	9	10
A-2	Ash + 20 cm of fertile soil + NPK	2b/	41.00	2.75	21.0	0.80	12.0	0.45	57.0
		2	51.50	3.75	22.0	0.57	18.0	0.40	77.0
A-3	-"-	3b/	40.50	2.50	23.0	0.42	10.2	0.36	49.0
		3	60.00	3.00	23.0	0.47	13.5	0.38	71.0
A-4	-"-	4b/	37.00	2.70	23.0	0.57	12.0	0.41	71.5
		4	49.25	3.35	23.0	0.37	14.0	0.40	70.0
B-2	Ash + 10 cm of fertile soil + NPK	2	53.00	3.10	23.0	0.48	12.2	0.46	70.5
B-3	-"-	3	53.50	2.50	19.0	0.57	9.5	0.46	51.0
B-4	-"-	4	60.00	2.30	21.0	1.12	13.1	0.51	54.0
C-2	Ash + 5 cm of fertile soil + NPK	2	52.50	2.50	19.0	1.02	11.0	0.42	66.0
C-3	-"-	3	58.50	2.50	21.0	0.62	12.2	0.46	60.0
C-4	-"-	4	53.00	2.60	23.0	0.72	15.0	0.47	91.0
D-1	Ash + bentonite + NPK	1	60.20	2.50	21.0	1.56	12.0	0.54	64.0
D-2	-"-	2	60.40	2.70	23.0	0.75	13.2	0.43	69.5
D-3	-"-	3	61.00	2.50	21.0	1.06	13.0	0.48	60.0
E-1	Ash + low moor peat + NPK	1	65.00	2.85	24.0	1.02	13.2	0.59	49.5
E-2	-"-	2	63.00	3.00	27.5	0.92	10.5	0.50	55.0
E-3	-"-	3	90.00	2.70	30.5	1.01	10.7	0.46	65.0
F-1	Ash + high moor peat + NPK	1	57.00	2.50	30.5	0.90	11.7	0.45	63.0
F-2	-"-	2	58.50	2.60	26.5	1.05	11.5	0.48	56.0
F-3	-"-	3	54.75	2.85	25.7	1.17	9.5	0.59	26.5
G-1	Ash + farm manure + NPK	1	40.25	3.20	28.5	1.79	14.2	0.46	67.0
G-2	-"-	2	48.75	3.00	26.5	1.00	11.5	0.52	46.5
G-3	-"-	3	40.00	2.70	25.0	1.05	15.0	0.66	58.0

Table 34. Continued

1	2	3	4	5	6	7	8	9	10
H/K/-1	Ash + N2PK + green manure	1	53.00	3.00	25.0	1.52	14.2	0.70	62.0
H/K/-2	-"-	2	53.00	2.70	23.0	1.25	14.0	0.63	55.0
H/K/-3	-"-	3	50.00	2.50	29.5	1.11	10.2	0.64	65.0
I-1	Ash + NPK	1	50.50	2.15	25.0	0.85	9.5	0.70	43.0
I-2	-"-	2	45.75	2.30	28.5	1.37	10.7	0.70	50.0
I-3	-"-	3	40.75	2.50	25.0	1.13	10.0	0.66	45.0
O-1	Ash nonfertilized in 1975	1	65.00	3.10	22.0	0.65	11.7	0.62	67.0
O-2	-"-	2	62.00	2.85	26.7	1.28	15.0	0.52	63.0
O-3	-"-	3	39.60	3.10	28.5	1.38	11.5	0.55	65.0

Notes: a/ Predecessors in 1975-80

1-mix of sainfoin with crown vetch
2-mix of grasses with legumes
3-mix of orchard grass with lucerne
4-white melilot

b/ Plots nonfertilized in 1977-80

Absorption of macro- and microelements by barley from plots fertilized in 1975-1981

HALEMBA

Table 35

No. of plot	Ash soil treatment	Type of predecessor a/	Absorption of macro- and microelements in conversion to 1 ha						
			N /kg/	P_2O_5 /kg/	K_2O /kg/	CaO /kg/	B /kg/	Mn /kg/	Zn /kg/
1	2	3	4	5	6	7	8	9	10
A-2	Ash + 20 cm of fertile soil + NPK	2	121	44	114	20	0.064	0.240	0.864
		2b/	117	42	83	27	0.063	0.146	0.643
A-3	-"-	3	82	37	81	13	0.047	0.133	0.586
		3b/	118	50	95	23	0.048	0.155	0.806
A-4	-"-	4	55	24	59	9	0.026	0.094	0.479
		4b/	109	39	84	21	0.049	0.205	1.032
B-2	Ash + 10 cm of fertile soil + NPK	2	52	29	76	15	0.039	0.098	0.432
B-3	-"-	3	78	32	71	14	0.040	0.100	0.589
B-4	-"-	4	78	31	65	21	0.049	0.102	0.647
C-2	Ash + 5 cm of fertile soil + NPK	2	92	33	75	18	0.048	0.110	0.401
C-3	-"-	3	48	21	46	10	0.035	0.055	0.200
C-4	-"-	4	60	20	63	12	0.037	0.054	0.212
D-1	Ash + bentonite + NPK	1	49	20	59	8	0.037	0.054	0.197
D-2	-"-	2	58	21	67	11	0.034	0.062	0.258
D-3	-"-	3	65	26	65	11	0.042	0.070	0.197
E-1	Ash + low moor peat + NPK	1	107	56	239	38	0.080	0.139	0.410
E-2	-"-	2	113	43	177	38	0.073	0.107	0.289
E-3	-"-	3	79	35	146	29	0.064	0.084	0.266
F-1	Ash + high moor peat + NPK	1	.	.	.	.	.	.	.
F-2	-"-	2	38	14	45	7	0.031	0.036	0.100
F-3	-"-	3	61	20	64	11	0.033	0.052	0.149
G-1	Ash + farm manure + NPK	1	79	24	78	10	0.036	0.075	0.202
G-2	-"-	2	83	28	86	10	0.045	0.074	0.180
G-3	-"-	3	105	35	105	19	0.056	0.092	0.266

Table 35. Continued

1	2	3	4	5	6	7	8	9	10
H-1	Ash + N2PK	1	97	36	135	27	0.076	0.106	0.252
H-2	-"-	2	104	41	148	27	0.079	0.120	0.423
H-3	-"-	3	80	27	109	22	0.050	0.111	0.239
I-1	Ash + NPK	1	96	33	87	18	0.088	0.091	0.273
I-2	-"-	2	77	30	75	12	0.055	0.089	0.269
I-3	-"-	3	75	31	92	14	0.049	0.081	0.228
O-1	Ash nonfertilized in 1975	1	82	34	92	20	0.067	0.075	0.221
O-2	-"-	2	79	32	108	18	0.054	0.086	0.281
O-3	-"-	3	85	37	136	26	0.064	0.106	0.235

Notes: a/ Predecessors in 1975-80:

1-lucerne
2-mix of grasses with legumes
3-mix of orchard grass with lucerne
4-white melilot

b/ Plots nonfertilized in 1977-80

Absorption of macro- and microelements by barley from plots
fertilized in 1975 - 1981

K O N I N

Table 36

No. of plot	Ash soil treatment	Type of predecessor a/	Absorption of macro- and microelements in conversion to 1 ha						
			N kg	P_2O_5 kg	K_2O kg	CaO kg	B kg	Mn kg	Zn kg
1	2	3	4	5	6	7	8	9	10
A-2	Ash + 20 cm of fertile soil + NPK	2	90	35	85	25	0.171	0.131	0.125
		$2^{b/}$	77	28	65	22	0.187	0.117	0.153
A-3	-"-	3	76	28	68	19	0.140	0.118	0.105
		$3^{b/}$	36	13	26	10	0.094	0.055	0.054
A-4	-"-	4	71	26	62	21	0.127	0.112	0.112
		$4^{b/}$	49	21	40	12	0.104	0.073	0.081
B-2	Ash + 10 cm of fertile soil + NPK	2	63	25	61	18	0.154	0.099	0.090
B-3	-"-	3	57	26	57	17	0.155	0.092	0.095
B-4	-"-	4	52	26	61	15	0.160	0.084	0.065
C-2	Ash + 5 cm of fertile soil + NPK	2	54	24	66	13	0.141	0.085	0.080
C-3	-"-	3	52	25	69	13	0.168	0.095	0.096
C-4	-"-	4	56	21	57	16	0.165	0.102	0.093
D-1	Ash + tertiary sand + NPK	1	48	20	60	12	0.161	0.086	0.081
D-2	-"-	2	52	21	57	13	0.158	0.086	0.114
D-3	-"-	3	46	18	51	12	0.142	0.069	0.089
E-1	Ash + low moor peat + NPK	1	40	16	52	8	0.124	0.069	0.069
E-2	-"-	2	54	20	66	11	0.149	0.095	0.084
E-3	-"-	3	52	21	70	11	0.218	0.106	0.080
F-1	Ash + high moor peat + NPK	1	62	23	87	14	0.173	0.132	0.104
F-2	-"-	2	40	16	57	10	0.118	0.076	0.065
F-3	-"-	3	52	16	61	12	0.140	0.098	0.072
G-1	Ash + farm manure + NPK	1	47	17	61	11	0.104	0.094	0.085
G-2	-"-	2	42	18	63	11	0.115	0.088	0.083
G-3	-"-	3	59	23	75	12	0.119	0.1[illegible]3	0.104
H/K/-1	Ash + N2PK + green manure	1	48	20	75	11	0.144	0.094	0.091
H/K/-2	-"-	2	51	21	79	12	0.133	0.086	0.088
H/K/-3	-"-	3	30	20	71	14	0.143	0.114	0.094

Table 36, Continued

1	2	3	4	5	6	7	8	9	10
I-1	Ash + NPK	1	61	25	92	17	0.167	0.119	0.115
I-2	-"-	2	53	22	75	13	0.128	0.110	0.079
I-3	-"-	3	38	23	87	12	0.122	0.106	0.095
0-1	Ash nonfertilized in 1975	1	52	21	55	13	0.174	0.095	0.099
0-2	-"-	2	27	12	36	7	0.090	0.055	0.061
0-3	-"-	3	34	20	76	15	0.120	0.117	0.091

Notes: a/ Predecessors in 1975 - 80 :

1 - mix of sainfoin with crown vetch
2 - mix of grasses with legumes
3 - mix of orchard grass with lucorne
4 - white melilot

b/ Plots nonfertilized in 1977 - 1980

Assessment of trees and shrubs increments in 1975–1981

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Table 37

Numbers of plots	Method of dressing x/	Kind of culture	Number of measured individuals	Average height /cm/		Average annual increments in years /cm/								Increment indicator /1975=100/	
				initial	final	1975	1976	1977	1978	1979	1980	1981	Total 1975–1981		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
I-1	1	Poplar I	3	147.7	370.0	13.3	13.3	28.0	21.0	29.4	17.3	100.0	222.3	251	
I-2	2	Poplar I	6	102.8	164.2	0.0	2.7	3.8	1.0	3.5	3.7	46.7	61.4	160	
I·3	3	Poplar I	8	96.1	198.1	3.7	0.8	12.8	2.9	7.8	8.4	65.6	102.0	206	
I-4	4	Poplar I	7	84.9	227.9	9.1	16.1	10.0	3.2	22.7	25.7	56.2	143.0	268	
		average	6	101.0	219.8	5.5	7.1	11.9	4.7	13.8	13.4	62.4	118.8	218	
II-1	1	Poplar II	7	118.7	290.7	18.2	15.2	24.2	21.1	22.5	18.7	52.1	172.0	245	
II-2	2	Poplar II	7	131.7	290.0	17.9	49.0	8.0	6.0	19.8	29.7	27.9	158.3	220	
II-3	3	Poplar II	6	40.3	193.3	19.4	13.6	26.9	15.5	31.3	20.5	25.8	153.0	480	
II-4	4	Poplar II	8	99.0	196.3	5.6	4.3	10.0	10.0	12.4	13.1	41.9	97.3	198	
		average	7	99.5	242.7	14.8	20.2	16.6	13.0	20.8	20.3	37.5	143.2	244	
III-1	1	Birch	6	60.7	175.0	7.3	28.3	10.4	10.0	7.5	11.6	39.2	114.3	288	
III-2	2	Birch	6	77.7	163.3	0.0	0.0	15.1	5.9	5.1	16.2	43.3	85.6	210	
III-3	3	Birch	3	6.7	116.7	5.0	11.6	30.0	6.7	8.3	13.4	35.0	110.0	1742	
III-4	4	Birch	4	77.5	115.0	0.0	0.0	10.0	8.8	2.5	0.0	16.2	37.5	148	
		average	5	61.0	149.5	3.2	10.7	14.9	7.9	5.9	10.9	35.0	88.5	245	
IV-1	1	Grey alder	22	105.8	383.2	7.6	9.0	26.4	33.7	43.8	64.4	92.5	277.4	362	
IV-2	2	Grey alder	21	101.0	348.1	4.1	633	20.6	23.2	45.3	77.0	70.6	247.1	345	
IV-3	3	Grey alder	23	84.8	379.3	3.9	3.6	24.5	34.6	56.7	74.3	96.9	294.5	447	
IV-4	4	Grey alder	24	97.8	364.6	1.0	2.7	18.5	26.7	61.6	80.9	75.4	266.8	373	
		average	23	97.2	369.1	4.1	5.3	22.4	29.6	52.2	74.3	84.0	271.9	380	
V-1	1	Black alder	17	60.0	353.3	7.3	38.3	16.3	18.2	43.5	69.3	82.4	275.3	559	
V-2	2	Black alder	15	92.5	352.0	6.6	42.3	8.6	27.0	54.9	52.8	67.3	259.5	380	
V-3	3	Black alder	13	51.9	384.2	10.0	32.6	32.0	30.1	67.2	62.7	97.7	332.3	740	
V-4	4	Black alder	19	46.7	352.6	6.8	48.8	24.7	19.3	54.5	66.8	85.0	305.9	755	
		average	16	62.0	354.3	7.6	41.2	20.2	22.9	54.3	63.4	82.7	292.3	571	

Table 37, Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
VI-1	1	Locust tree	21	51.4	483.3	79.7	43.9	90.0	36.9	69.0	41.0	71.4	431.9	940	
VI-2	2	Locust tree	17	57.8	471.1	56.6	38.5	93.8	37.4	61.2	49.4	76.4	413.3	815	
VI-3	3	Locust tree	18	58.3	472.2	65.7	48.8	88.8	18.5	89.2	48.4	54.4	413.9	809	
VI-4	4	Locust tree	18	58.9	512.8	56.1	36.4	96.6	48.9	97.0	51.6	67.3	453.9	870	
		average	19	56.4	485.0	65.2	42.0	92.3	35.4	79.0	47.3	67.4	428.6	860	
VII-1	1	Larch	14	80.3	204.6		14.4	17.1	10.8	21.4	28.1	32.5	124.3	255	
VII-2	2	Larch	18	95.3	282.8		12.8	12.8	17.9	37.1	52.1	54.8	187.5	296	
VII-3	3	Larch	13	69.7	228.1		14.0	13.0	12.1	30.9	42.2	46.2	158.4	327	
VII-4	4	Larch	15	58.4	236.3		13.2	12.5	18.0	39.2	40.3	54.7	177.9	405	
		average	15	77.0	241.0		13.5	13.8	15.0	32.6	41.5	47.6	164.0	313	
VIII-1	1	Pea shrub	23	29.3	243.5	6.9	34.8	63.3	19.0	32.9	36.6	20.7	214.2	831	
VIII-2	2	-"-	24	32.1	265.4	10.9	40.6	65.2	26.0	26.8	35.1	28.7	233.3	827	
VIII-3	3	-"-	23	26.5	267.6	11.1	45.8	59.4	25.4	23.1	37.2	39.1	241.1	192	
VIII-4	4	-"-	22	35.3	236.4	6.1	35.7	49.7	22.2	19.1	41.9	26.4	201.1	669	
		average	23	30.8	253.5	8.8	39.2	58.6	23.2	37.9	25.3	28.7	222.7	823	
IX-1	1	Willow	21	41.0	171.4	6.4	10.9	15.4	6.3	19.1	27.8	44.5	130.4	418	
IX-2	2	Willow	22	35.9	164.5	5.8	12.5	4.3	4.3	15.8	28.3	57.6	128.6	458	
IX-3	3	Willow	24	37.7	210.6	4.1	24.7	12.0	6.8	26.0	30.1	69.2	172.9	558	
IX-4	4	Willow	23	34.3	171.5	3.6	25.4	16.0	4.3	27.2	19.2	41.5	137.2	500	
		average	23	37.2	180.2	4.9	18.7	11.9	5.4	22.2	26.4	53.5	143.0	484	
		average I-IX	60	62.9	297.0	14.0	24.5	34.3	20.2	39.4	43.7	58.0	243.1	472	
		Combination 1	134	65.1	302.5	18.4	24.8	37.9	21.0	36.6	41.3	57.4	237.4	465	
		-"- 2	136	71.9	291.7	12.2	23.9	31.0	19.5	34.3	44.0	54.9	219.8	406	
		-"- 3	131	54.4	301.4	14.6	25.5	36.3	19.5	42.9	43.9	64.3	247.0	554	
		-"- 4	140	60.2	292.8	10.7	24.0	32.0	20.6	44.0	45.7	55.6	232.6	406	
		average 1-4		62.9	297.0	14.0	24.5	34.3	20.2	39.4	43.7	58.0	234.1	472	

Assessment of trees and shrubs increase in 1975 - 1981

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Table 38

Numbers of plots	Method of pit dressing	Kind of culture	Number of measured individuals	Average height [cm]		Average annual increase in years [cm]								Increase indicator /year 1976 =100/	
				initial	final	MAY 1976	OCT 1976	SEPT 1977	SEPT 1978	SEPT 1979	SEPT 1980	SEPT 1981	TOTAL 1976–81		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
I-1	1	Poplar I	6	104,8	218.3		4,1	1.14	4.1	7.2	40.8	50.0	113.5	208	
I-2	2	Poplar I	9	106.2	277.2		13,2	12.4	7.6	21.1	57.7	72.2	171.0	261	
I-3	3	Poplar I	9	152.2	272.2			14.3	9.9	11.9	38.9	43.0	120.0	179	
I-4	4	Poplar I	9	149.8	255.5			17.1	12.5	9.5	31.1	45.5	105.7	170	
I-5	5	Poplar I	9	144.6	278.9		33.9	27.7	27.1	17.5	24.7	37.2	134.3	193	
		average	8	133.45	263.45			16.95	12.84	13.88	36.33	50.0	130.0	197	
II-1	1	Poplar II	5	148.5	236.0			1.6	2.8	10.8	20.2	52.0	87.4	159	
II-2	2	Poplar II	9	147.9	363.3			11.3	27.1	32.8	52.3	93.6	217.4	247	
II-3	3	Poplar II	8	118.1	255.0			17.9	16.2	9.7	36.2	56.9	136.9	216	
II-4	4	Poplar II	9	130.0	265.6			17.1	22.9	11.7	23.3	60.5	135.5	204	
II-5	5	Poplar II	8	181.6	359.4		5.6	13.8	36.7	27.2	31.3	68.8	177.8	198	
		average	8	144.67	301.87			13.28	22.77	19.21	33.95	68.02	157.20	309	
III-1	1	Birch	20	71.3	273.0			26.5	26.5	41.3	30.0	57.4	201.7	383	
III-2	2	Birch	20	72.9	319.0			21.7	36.6	54.9	58.5	74.3	246.1	437	
III-3	3	Birch	19	80.5	281.0			17.6	41.2	34.0	49.8	58.9	200.5	349	
III-4	4	Birch	20	72.8	261.5			21.7	37.2	39.1	36.4	54.5	188.9	360	
III-5	5	Birch	20	50.9	277.5			46.7	28.3	31.5	43.3	76.8	226.6	545	
		average	20	69.54	282.42			26.95	33.88	40.24	47.39	64.42	212.86	406	
IV-1	1	Gray alder	6	29.8	155.0			11.8	18.2	18.5	37.5	39.2	125.2	520	
IV-2	2	Gray alder	6	38.3	200.8			21.3	24.0	23.4	31.3	62.5	162.5	524	
IV-3	3	Gray alder	3	39.3	190.0			21.4	23.3	16.0	41.7	48.3	150.7	483	
IV-4	4	Gray alder	5	53.0	276.0			37.0	41.4	24.6	26.0	94.0	223.0	521	
IV-5	5	Gray alder	20	64.5	343.0		28.9	60.1	61.3	34.2	35.9	87.0	278.5	532	
		average	8	52.07	273.62			41,23	43.90	27.67	34,63	74,12	221,55	525	
V-1	1	Black alder	18	53.2	165.3			27.8	5.9	12.0	38.8	27.6	112.1	311	
V-2	2	Black alder	20	44.5	210.7			30.4	14.6	17.9	45.3	50.00	166.2	473	
V-3	3	Black alder	18	73.5	189.0			13.7	8.9	11.2	39.4	42.3	115.5	257	
V-4	4	Black alder	19	75.3	232.6			13.1	18.7	16.2	50.1	59.2	157.3	309	
V-5	5	Black alder	20	89.1	334.5		44.4	26.1	38.6	32.2	64.7	83.8	245.4	375	
		average	19	67.20	228.44			24.06	17.77	18.16	48.04	53.21	161.24	340	

Table 38. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VI-1	1	Locust tree	15	61,5	334,8			32,8	21,5	41.9	65.3	91.6	253.1	410
VI-2	2	Locust tree	10	47.0	315.0			62.5	33.4	24.7	59.8	87.5	268.0	670
VI-3	3	Locust tree	18	102.3	337.7		35.5	45.1	30.6	20.6	60.6	78.5	235.4	330
VI-4	4	Locust tree	16	114.5	401.2			46.2	53.4	20.9	62.2	104.0	286.7	350
VI-5	5	Locust tree	17	123.0	410.0		26.5	41.2	69.8	4.8	83.0	88.2	287.0	333
		average	15	98.16	363.68			44.30	42.75	21.87	66.73	89.87	265.52	370
VII-1	1	Willow	10	13.1	110.0			48.9	22.8	11.8	7.5	5.9	96.9	839
VII-2	2	Willow	19	26.6	207.9			59.3	35.0	20.2	26.5	40.3	181.3	266
VII-3	3	Willow	18	9.8	151.9			57.2	42.9	16.7	6.3	19.0	142.1	155
VII-4	4	Willow	18	36.2	206.4			57.6	40.1	19.3	12.5	40.7	170.2	570
VII-5	5	Willow	20	108.4	311.0			63.3	53.9	5.6	20.4	59.4	202.6	287
		average	17	42.73	208.47			58.23	40.76	14.87	15.57	36.31	165.74	488
VIII-1	1	Sea buckthorn	17	64.4	155.3			8.3	5.8	10.3	31.5	35.0	90.9	241
VIII-2	2	Sea buckthorn	14	61.5	134.3			14.3	9.9	9.5	22.3	16.8	72.8	218
VIII-3	3	Sea buckthorn	20	67.5	162.5			24.9	7.1	12.5	23.7	26.4	95.0	241
VIII-4	4	Sea buckthorn	14	64.3	179.3			20.0	8.6	17.5	26.2	42.7	115.0	279
VIII-5	5	Sea buckthorn	19	84.6	213.1		7.5	24.0	23.4	20.5	22.3	38.3	128.5	252
		average	17	60.33	170.59			18.74	11.24	14.20	25.14	31.94	101.26	246
IX-1	1	Pea shrub	17	19.0	156.5			11.0	14.0	21.2	40.4	50.9	137.5	824
IX-2	2	Pea shrub	15	25.1	136.0			1.8	17.0	23.4	34.4	34.3	110.9	542
IX-3	3	Pea shrub	16	29.2	161.9			11.5	14.4	21.8	32.8	52.2	132.7	554
IX-4	4	Pea shrub	18	29.9	156.1			4.2	6.9	18.1	35.7	61.4	126.3	524
IX-5	5	Pea shrub	8	52.5	196.3			19.9	11.0	28.7	32.3	51.9	143.8	374
		average	15	28,70	137,70			8.53	12.67	21.82	35.51	50.47	129.00	549
XI-1	1	Larch tree	10	36.3	69.3			7.2	3.9	5.6	7.2	9.1	33.0	191
XI-2	2	Larch tree	11	34.5	64.0			7.3	0.3	8.3	3.6	10.0	29.5	185
XI-3	3	Larch tree	7	30.1	47.8			6.2	1.0	1.7	1.0	7.8	17.7	159
XI-4	4	Larch tree	2	60.0	75.0			9.5	0.0	1.5	4.0	0.0	15.0	125
XI-5	5	Larch tree	13	35.7	123.7			9.5	11.0	11.7	21.9	33.9	88.0	346
		average	9	35.77	81.16			7.86	4.46	7.30	9.59	16.18	45.39	227
		average I-XI	68	69.68	233.82			27.61	25.13	20.97	36.98	53.45	164.14	335
	1	Combination 1	124	57.01	193.29			20.63	13.81	20.87	37.23	43.74	136.28	339
	2	Combination 2	133	56.10	220.35			27.09	29.22	17.12	53.17	37.65	164.25	393
	3	Combination 3	136	68.68	211.70			25.61	21.58	17.36	33.91	44.51	143.02	308
	4	Combination 4	130	74.67	240.96			25.59	26.66	20.30	34.21	59.33	166.29	323
	5	Combination 5	154	88.30	291.58			37.15	39.24	21.43	39.84	63.62	203.28	330
		average 1-5		69.68	233.92			27.61	25.13	20.97	36.98	53.45	164.14	335

Assessment of trees and shrubs' cultivation successfulness

H A L E M B A

Table 39

Numbers of plots	Kind of culture	Method of pit dressing	Cuttings in years /spc./				Losses in years /spc./								Percent of losses $\frac{col.15}{col.7}.100$	Number of remained cuttings on 31.Dec. 1981 /spc./
			1975	1976	1977	Total	1975	1976	1977	1978	1979	1980	1981	Total		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I-1	Poplar I	1a/	9	-	-	9	-	-	1	2	1	2	-	6	66.7	3
I-2	Poplar I	2	9	-	-	9	-	-	-	1	1	1	-	6	66.7	6
I-3	Poplar I	3	9	-	-	9	-	-	-	1	-	-	-	1	11,1	8
I-4	Poplar I	4	9	-	-	9	-	-	1	1	-	-	-	2	22.2	7
II-1	Poplar II	1a/	9	-	-	9	-	-	-	-	-	2	-	2	22.2	7
II-2	Poplar II	2	9	1	1	11	1	1	-	-	-	-	2	4	36.4	7
II-3	Poplar II	3	9	-	-	9	-	-	-	-	1	-	2	3	33.3	6
II-4	Poplar II	4	9	2	-	11	2	-	-	-	1	-	3	3	27.3	8
III-1	Birch	1a/	24	23	-	47	21	2	18	-	-	-	-	41	87.2	6
III-2	Birch	2	24	24	-	48	24	-	17	-	-	1	-	42	87.5	6
III-3	Birch	3	24	24	-	48	22	2	20	1	-	-	-	45	93.8	3
III-4	Birch	4	24	24	-	48	23	1	19	1	-	-	-	44	91.7	4
IV-1	Gray alder	1a/	24	5	5	34	4	6	2	-	-	-	-	12	35.3	22
IV-2	Gray alder	2	24	6	9	39	14	1	3	-	-	-	-	18	46.2	21
IV-3	Gray alder	3	24	7	9	40	14	2	1	-	-	-	-	17	42.5	23
IV-4	Gray alder	4	24	9	13	46	18	4	-	-	-	-	-	22	47.8	24
V-1	Black alder	1a/	24	23	-	47	5	18	5	1	-	1	-	30	63.9	17
V-2	Black alder	2	24	24	-	48	10	7	7	8	-	-	1	33	68.8	15
V-3	Black alder	3	24	15	-	39	6	9	10	1	-	-	-	26	66.7	13
V-4	Black alder	4	24	17	-	41	4	13	1	3	-	1	-	22	53.7	19
VI-1	Locust tree	1a/	24	-	-	24	-	-	-	-	1	-	2	3	12.5	21
VI-2	Locust tree	2	24	1	-	25	1	-	-	-	4	1	2	8	32.0	17
VI-3	Locust tree	3	24	-	-	24	-	-	-	3	1	2	-	6	25.0	18
VI-4	Locust tree	4	24	-	-	24	-	-	-	1	-	2	3	6	25.0	18
VII-1	Larch tree	1a/	24	30	-	54	24	6	10	-	-	-	-	40	74.1	14
VII-2	Larch tree	2	24	32	-	56	24	6	6	2	-	-	-	38	67.9	18
VII-3	Larch tree	3	24	32	-	56	24	8	11	-	-	-	-	43	76.8	13
VII-4	Larch tree	4	24	36	-	60	24	12	9	-	-	-	-	45	75.0	15
..	. .. .															

Table 39 Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
VIII-1	Pea shrub	1[a/]	24	7	-	31	2	5	1	-	-	-	-	8	25.8	23
VIII-2	Pea shrub	2	24	5	-	29	1	4	-	-	-	-	-	5	17.2	24
VIII-3	Pea shrub	3	24	5	-	29	1	4	1	-	-	-	-	6	20.7	23
VIII-4	Pea shrub	4	24	11	-	35	-	11	2	-	-	-	-	13	37.1	22
IX-1	Willow	1[a/]	24	8	-	32	6	2	-	-	1	2	-	11	34.3	21
IX-2	Willow	2	24	9	-	33	8	1	1	-	1	-	-	11	33.3	22
IX-3	Willow	3	24	6	-	30	3	3	-	-	-	-	-	6	20.0	24
IX-4	Willow	4	24	12	-	36	7	5	-	-	-	1	-	13	36.1	23
X-1	Willow shoot cuttings	1[b/]	48	-	32	80	-	32	14	7	5	5	-	63	78.8	17
X-2	-"-	2	48	-	42	90	-	42	15	2	-	16	-	75	83.3	15
X-3	-"-	3	48	-	45	93	-	45	18	5	4	11	-	83	89.2	10
X-4	-"-	4	48	-	47	95	-	47	22	1	11	10	-	91	95.8	4
XI-1	Poplar shoot cuttings	1[b/]	48	-	36	84	36	-	29	4	2	-	-	71	84.5	13
XI-2	-"-	2	48	-	37	85	37	-	15	-	1	7	-	60	70.6	25
XI-3	-"-	3	48	-	29	77	29	-	29	-	-	2	-	60	77.9	17
XI-4	-"-	4	48	-	22	70	22	-	15	-	-	1	-	38	54.3	32

Explanation to col. 3

a/

1 - pits dressed with ash + fertile soil + NP
2 - pits dressed with ash + bentonite + NP
3 - pits dressed with ash + high moor peat + NP
4 - pits dressed with ash + NP

b/ soil treatment before planting shoot cuttings:

1 - 20 cm of fertile soil + NPK
2 - addition of bentonite + NPK
3 - addition of high moor peat + NPK
4 - mineral fertilizers NPK

Assessment of trees and shrubs' cultivation successfulness

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Table 40

Numbers of plots	Kind of culture	Method of pit dressing	Cuttings in years /spc./				Losses in years /spc./								Percent of losses $\frac{\text{col.15}}{\text{col.7}} \cdot 100$	Number of remained cuttings on 31 Dec. 1981 /spec./
			1975	1976	1977	Total	1975	1976	1977	1978	1979	1980	1981	Total		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I-1	Poplar I	1[a/]	9	9	-	18	8	1	3	-	-	-	-	12	66.7	6
I-2	-"-	2	9	9	-	18	2	7	-	-	-	-	-	9	50.0	9
I-3	-"-	3	9	9	-	18	4	5	-	-	-	-	-	9	50.0	9
I-4	-"-	4	9	9	-	18	7	2	-	-	-	-	-	9	50.0	9
I-5	-"-	5	-	9	-	9	-	-	-	-	-	-	-	0	0.0	9
II-1	Poplar II	1[a/]	9	9	-	18	8	1	4	-	-	-	-	13	72.2	5
II-2	-"-	2	9	9	-	18	7	2	-	-	-	-	-	9	50.0	9
II-3	-"-	3	9	9	-	18	5	4	1	-	-	-	-	10	55.5	8
II-4	-"-	4	9	9	-	18	7	2	-	-	-	-	-	9	50.0	9
II-5	-"-	4	9	9	-	18	-	-	1	-	-	-	-	1	111.1	8
III-1	Birch	1[a/]	20	39	-	59	20	19	-	-	-	-	-	39	66.1	20
III-2	-"-	2	20	40	-	60	20	20	-	-	-	-	-	40	66.7	20
III-3	-"-	3	20	38	-	58	20	18	1	-	-	-	-	39	67.2	19
III-4	-"-	4	20	38	-	58	20	18	-	-	-	-	-	38	65.5	20
III-5	-"-	5	-	26	-	26	-	6	-	-	-	-	-	6	23.1	20
IV-1	Gray alder	1[a/]	20	30	-	50	20	10	1	4	-	4	5	44	88.0	6
IV-2	-"-	2	20	26	-	46	20	6	1	1	3	5	4	40	87.0	6
IV-3	-"-	3	20	27	-	47	20	7	2	1	5	1	8	44	93.6	3
IV-4	-"-	4	20	22	-	42	20	2	-	-	2	5	8	37	88.0	5
IV-5	-"-	5	-	20	-	20	-	-	-	-	-	-	-	0	0.0	20
V-1	Black alder	1[a/]	20	40	-	60	20	20	1	1	-	-	-	42	70.0	18
V-2	-"-	2	20	33	-	53	20	13	-	-	-	-	-	33	62.2	20
V-3	-"-	3	20	38	-	58	20	18	1	-	1	-	-	40	69.0	18
V-4	-"-	4	20	35	-	55	20	15	1	-	-	-	-	36	65.5	19
V-5	-"-	5	-	28	-	28	-	8	-	-	-	-	-	8	28.6	20
VI-1	Locust tree	1[a/]	20	33	-	53	20	13	3	1	-	-	1	38	71.7	15
VI-2	-"-	2	20	21	-	41	20	1	7	-	-	3	-	31	75.6	10
VI-3	-"-	3	20	24	-	44	20	4	1	-	-	1	-	26	59.1	18
VI-4	-"-	4	20	21	-	41	20	1	3	1	-	-	-	25	61.0	16
VI-5	-"-	5	-	23	-	23	-	3	3	-	-	-	-	6	26.1	17

Table 40. Continued

1	2	3	44	5	6	7	8	9	10	11	12	13	14	15	16	17
VII-1	Willow	1a/	20	31	-	51	20	11	-	1	4	4	1	41	80.4	10
VII-2	Willow	2	20	30	-	50	20	10	-	1	-	-	-	31	62.0	19
VII-3	Willow	3	20	37	-	57	20	17	-	-	-	-	2	39	68.4	18
VII-4	Willow	4	20	29	-	49	20	9	-	1	-	-	1	31	63.3	18
VII-5	Willow	5	-	20	-	20	-	-	-	-	-	-	-	0	0.0	20
VIII-1	Sea buckthorn	1a/	20	35	-	55	20	15	2	-	-	1	-	38	69.1	17
VIII-2	Sea buckthorn	2	20	32	-	52	20	12	2	-	-	2	2	38	73.1	14
VIII-3	Sea buckthorn	3	20	29	-	49	20	9	-	-	-	-	-	29	59.2	20
VIII-4	Sea buckthorn	4	20	30	-	50	20	10	4	-	2	-	-	36	72.0	14
VIII-5	Sea buckthorn	5	-	24	-	24	-	4	-	1	-	-	-	5	20.8	19
IX-1	Pea shrub	1a/	20	24	-	44	20	4	3	-	-	-	-	27	61.4	17
IX-2	Pea shrub	2	20	30	-	50	20	10	5	-	-	-	-	35	70.0	15
IX-3	Pea shrub	3	20	34	-	54	20	14	2	2	-	-	-	38	70.4	16
IX-4	Pea shrub	4	20	31	-	51	20	11	1	1	-	-	-	33	64.7	18
IX-5	Pea shrub	5	-	21	-	21	-	1	1	6	-	5	-	13	61.9	8
XI-1	Larch tree	1a/	-	20	20	40	-	20	1	1	-	7	1	30	75.0	10
XI-2	Larch tree	2	-	20	20	40	-	20	-	1	-	8	-	29	72.5	11
XI-3	Larch tree	3	-	20	20	40	-	20	1	4	-	7	1	33	82.5	7
XI-4	Larch tree	4	-	20	20	40	-	20	4	1	-	12	1	38	95.0	2
XI-5	Larch tree	5	-	20	20	40	-	20	1	1	2	3	-	27	67.5	13
X-1	Poplar shoot cuttings	1b/	40	18	-	58	18	-	17	1	-	-	-	37	63.8	21
X-2	-"-	2	40	57	--	97	35	22	13	-	1	4	2	77	79.4	20
X-3	-"-	3	40	65	-	105	35	30	5	1	4	15	-	90	85.7	15
X-4	-"-	4	40	54	-	94	30	24	1	5	6	4	-	70	74.5	24

Explanation to col. 3:

a/ 1 - pits dressed with ash + fertile soil + NP
2 - pits dressed with ash + tertiary sand + NP
3 - pits dressed with ash + high moor peat + NP
4 - pits dressed with ash + NP
5 - fertile soil + NP

b/ soil treatment before planting shoot cuttings:
1 - 20 cm layer of fertile soil + NPK
2 - addition of tertiary sand + NPK
3 - addition of peat + NPK
4 - mineral fertilizers NPK

Table 41

Chemical composition of robinia leaves

HALEMBA

Name of combination	Method of pit dressing x/	Observational year	Humidity of sample percent	Content [percent]								Content [ppm]						
				ash	protein	N	P_2O_5	K_2O	CaO	MgO	Na_2O	B	Mn	Mo	Zn	Fe	Co	Cu
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
VI-1	1	1977	7.60	6.47	25.13	4.02	0.65	1.90	2.74	0.42		64	29	4.5	90	450	0.41	-
		1978	7.35	6.57	19.06	3.05	0.41	0.97	3.72	0.61	0.053	91	20	5.9	68	225	-	3.5
		1979	8.48	7.51	15.62	2.50	0.31	0.84	4.28	0.83	0.062	155	33	4.3	100	750	0.30	-
		1980	7.09	6.80	21.25	3.40	0.63	1.42	2.16	0.58	0.001	80	16	4.6	33	322	0.57	7.5
		1981	7.22	7.32	18.75	3.00	0.45	1.15	2.75	0.53	0.030	68	21	3.8	40	191	0.48	4.9
		Average	7.55	6.79	19.96	3.19	0.49	1.26	3.13	0.59	0.037	92	24	4.6	66	388	0.44	5.3
VI-2	2	1977	7.60	6.01	24.63	3.94	0.70	1.62	2.71	0.42	-	59	28	3.9	70	512	0.41	-
		1978	7.68	7.00	17.19	2.75	0.41	0.85	4.08	0.66	0.047	155	20	3.8	47	250	-	3.6
		1979	8.35	7.43	14.00	2.24	0.29	0.67	4.10	0.70	0.061	120	25	3.5	106	500	0.30	-
		1980	7.19	6.19	20.00	3.20	0.73	1.72	1.94	0.50	0.001	76	16	2.0	28	294	0.50	6.5
		1981	7.11	7.16	19.69	3.15	0.50	1.18	2.67	0.53	0.022	62	20	2.2	43	330	0.48	5.0
		Average	7.59	6.76	19.10	3.06	0.53	1.21	3.10	0.56	0.033	94	22	3.1	59	377	0.42	5.0
VI-3	3	1977	7.96	6.73	24.38	3.90	0.65	1.85	2.83	0.42		51	28	2.7	88	512	0.47	-
		1978	7.11	6.65	17.62	2.82	0.45	1.16	3.59	0.50	0.046	65	18	4.2	66	275	-	2.7
		1979	7.84	6.64	15.31	2.45	0.36	0.84	3.75	0.61	0.066	80	27	3.0	100	650	0.32	-
		1980	7.17	6.25	19.25	3.08	0.61	1.24	2.50	0.51	0.002	74	18	4.3	29	310	0.72	5.5
		1981	7.50	7.94	18.25	2.92	0.48	1.04	3.01	0.54	0.046	65	22	2.8	61	170	0.52	4.7
		Average	7.52	6.84	18.96	3.03	0.51	1.23	3.14	0.52	0.040	67	23	3.4	69	383	0.51	4.3
..	. .. .																	

Table 41. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
VI-4	4	1977	8.42	7.42	23.31	3.73	0.65	1.84	3.24	0.46		58	33	3.6	75	512	0.38	-
		1978	7.34	7.46	17.75	2.84	0.44	0.99	4.42	0.53	0.047	123	23	2.6	47	250	-	2.7
		1979	7.57	7.77	14.69	2.35	0.31	0.98	4.22	0.48	0.059	60	29	2.7	75	450	0.30	-
		1980	7.41	6.28	20.00	3.20	0.59	0.90	2.96	0.44	0.001	48	22	2.9	22	306	0.61	4.5
		1981	7.50	8.87	20.63	3.30	0.51	1.34	3.18	0.54	0.048	84	24	4.8	40	197	0.52	4.5
		Average	7.65	7.56	19.28	3.08	0.50	1.21	3.60	0.49	0.039	75	26	3.3	52	343	0.45	3.9

x/ Method of pit dressing for planting trees:

1 - mixture of ash and fertile soil + NP
2 - mixture of ash with bentonite + NP
3 - mixture of ash with high moor peat + NP
4 - ash + NP

Chemical composition of robinia leaves

K O N I N

Table 42

Name of combination	Method of pit dressing	Observational year	Humidity of sample percent	Content [percent]								Content [ppm]						
				ash	protein	N	P_2O_5	K_2O	CaO	MgO	Na_2O	B	Mn	Mo	Zn	Fe	Co	Cu
1	2 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
VI-1	1	1977	8.11	7.55	20.00	3.20	0.60	2.04	3.55	0.42	-	280	45	11.8	34	190	0.40	-
		1978	7.86	7.94	11.38	1.82	0.21	0.77	5.46	0.38	0.096	350	37	8.7	16	175	-	2.7
		1979	9.82	9.76	10.31	0.13	0.13	0.78	5.74	0.58	0.095	235	55	4.4	59	375	0.24	-
		1980	7.81	5.76	16.50	2.54	0.55	1.28	3.11	0.38	0.014	225	36	4.0	17	246	0.57	5.0
		1981	7.50	9.86	16.75	2.52	0.26	1.23	3.74	0.38	0.034	175	34	4.3	17	205	0.50	4.4
		$\overline{x}$	8.22	8.37	14.79	2.37	0.35	1.22	4.32	0.43	0.060	253	41	6.6	29	238	0.43	4.0
VI-2	2	1977	8.60	7.85	17.00	2.72	0.56	1.66	4.12	0.42	-	345	45	18.3	27	220	0.40	-
		1978	7.90	7.31	11.19	11.79	0.21	0.72	5.22	0.40	0.098	260	29	7.0	13	162	-	2.5
		1979	9.40	9.44	8.59	1.39	0.13	0.47	6.09	0.60	0.092	330	56	4.1	55	438	0.29	-
		1980	7.59	7.05	18.94	3.03	0.45	1.04	3.20	0.40	0.009	200	25	4.0	15	294	0.45	4.5
		1981	7.84	10.32	15.25	2.44	0.29	1.01	4.03	0.48	0.034	200	41	6.4	17	192	0.38	3.2
		$\overline{X}$	8.29	9.39	14.21	2.27	0.33	0.98	4.53	0.46	0.058	267	39	7.6	25	281	0.38	3.4
VI-3	3	1977	8.58	8.41	19.94	3.19	0.65	1.78	4.27	0.53	-	300	46	8.9	18	240	0.32	-
		1978	8.65	8.97	12.13	1.94	0.25	0.57	6.50	0.46	0.065	330	47	5.3	16	200	-	2.6
		1979	9.60	11.12	10.52	1.68	0.16	0.53	6.50	0.53	0.091	325	82	4.4	65	400	0.26	-
		1980	7.96	7.03	17.94	2.87	0.40	0.86	3.72	0.42	0.010	255	26	4.0	16	296	0.51	4.5
		1981	8.45	11.57	13.15	2.10	0.30	0.68	4.86	0.46	0.044	462	39	3.9	17	175	0.38	3.5
		$\overline{X}$	8.65	9.42	14.74	2.36	0.35	0.89	5.17	0.48	0.053	334	48	5.3	26	262	0.37	3.5

Table 42. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
VI-4	4	1977	8.24	8.33	17.06	2.73	0.60	1.78	4.41	0.46	-	304	51	12.5	28	200	0.27	-
		1978	8.35	9.41	11.06	1.77	0.23	0.54	6.64	0.43	0.071	410	34	6.9	11	225	-	2.5
		1979	9.84	12.49	8.13	1.30	0.13	0.34	7.70	0.63	0.097	400	32	3.6	68	325	0.21	-
		1980	7.60	7.50	18.19	2.91	0.43	0.92	3.84	0.43	0.005	188	26	2.8	16	284	0.51	5.5
		1981	8.31	10.90	15.00	2.40	0.29	0.76	4.40	0.51	0.039	244	46	3.4	14	167	0.38	3.5
		$\overline{X}$	8.49	8.73	13.89	2.22	0.34	0.87	5.40	0.49	0.053	309	48	5.8	27	240	0.34	3.8
VI-5	5	1977	6.80	8.54	19.81	3.17	0.65	1.90	3.20	0.30	-	335	33	11.3	26	512	0.38	
		1978	7.23	7.21	14.25	2.28	0.30	1.00	4.51	0.28	0.059	265	25	5.0	15	75	-	2.0
		1979	8.54	9.77	11.50	1.84	0.29	0.58	6.03	0.46	0.090	399	49	4.0	68	275	0.16	-
		1980	7.32	6.86	19.94	3.19	0.53	1.42	3.10	0.28	0.002	220	22	3.0	19	256	0.50	5.5
		1981	7.51	9.59	15.31	2.45	0.44	1.08	3.90	0.33	0.033	176	36	3.3	18	114	0.53	4.4
		$\overline{X}$	7.48	8.39	16.16	2.59	0.44	1.20	4.13	0.33	0.046	279	33	5.3	29	246	0.39	4.0

x/ Method of pit dressing for planting trees:

1-mixture of ash and fertile soil + NP
2-mixture of ash with tertiary sand + NP
3-mixture of ash with high moor peat + NP
4-ash + NP
5-fertile soil + NP

Changes of pH reaction in produced ash soils

Halemba

Table 43

No. of plot	Combinations of soils and fertilizers	No. of mix-ture	Sampl-ing depth cm	measured value of pH in KCl																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				s	a	s	a	s	a	s	s	a	s	a	s	a	s	s	a	s	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	6.0	4.8	7.6	4.0	5.0 4.7 8.3	5.6	5.7 5.3 8.4	5.1	5.1	5.3 5.4 6.3		5.4 5.0 7.8	4.4	5.3 7.4 8.4	5.3	5.0	5.1 6.2 6.3	
A-3	-"-	3	5-10 10-20 30	4.2	5.0	6.7	4.1	4.9 5.1 8.3	5.4	5.1 4.9 8.8	4.5	4.4	4.7 5.9 7.5		5.4 5.7 8.3	4.2	4.9 4.7 8.8	4.9	5.0	4.6 4.4 7.5	
A-4	-"-	4	5-10 10-20 30	6.4	5.8	6.6	6.1	4.5 4.8 8.3	5.6	4.8 8.0 8.7	4.2	4.4	4.5 4.3 7.4		5.2 5.7 8.4	6.4	7.6 8.3 8.7	4.6	4.4	5.0 4.7 7.4	
B-2	Ash + 10 cm of fertile	2	5-10 10-20 30	5.2	4.6	5.6	5.2	5.6 5.0 8.4	5.8	8.0 8.1 8.8	5.0	5.6	5.0 6.9 7.6		6.7 7.6 8.6	5.3	7.8 8.8 8.8	4.5	4.6	5.9 7.5 7.6	
B-3	-"-	3	5-10 10-20 30	5.8	5.2	5.6	5.3	6.6 6.3 9.6	4.7	8.0 8.1 8.6	4.8	6.2	5.5 7.2 7.8		4.9 6.4 8.5	5.5	6.2 8.2 8.6	6.5	5.2	5.6 6.4 7.8	
B-4	-"-	4	5-10 10-20 30	5.6	5.6	5.7	5.5	6.6 7.6 8.9	7.7	6.7 5.7 9.0	4.9	5.9	6.3 7.2 7.4		4.4 6.9 8.5	6.8	4.8 7.8 9.0	6.9	4.3	5.0 5.3 7.4	
C-2	Ash + 5 cm of fertile	2	5-10 10-20 30	5.9	7.5	7.0	4.2	7.7 8.6 8.8	8.1	8.0 8.9 9.3	8.0	7.2	7.8 8.0 8.2		7.8 6.2 8.9	7.3	8.1 8.9 9.3	6.7	8.3	6.7 7.4 8.2	
C-3	-"-	3	5-10 10-20 30	6.7	7.1	6.9	6.9	8.4 9.7 10.1	8.3	9.0 9.2 10.5	8.2	7.8	7.7 8.2 8.3		8.5 8.5 9.9	7.7	8.5 9.1 10.5	6.9	7.3	7.9 8.1 8.3	
C-4	-"-	4	5-10 10-20 30	7.1	7.8	7.6	7.2	8.5 9.1 10.5	9.6	9.0 10.9 11.0	8.4	8.2	7.9 8.7 9.3		8.6 9.2 10.0	8.2	9.2 9.5 11.0	8.3	7.2	8.0 9.3 9.3	

Table 43. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5-10 10-20 30	8.2	8.3	7.8	8.2	8.7 10.4 8.9	9.5	9.4 10.3 11.6	8.2	8.0	8.1 8.4 8.4		8.0 8.1 8.8	8.1	9.0 8.9 11.6	8.5	8.1	7.8 7.9 8.4	
D-2	-"-	2	5-10 10-20 30	8.4	8.6	8.2	8.3	9.4 9.5 10.1	8.8	9.9 11.0 11.1	8.8	8.7	8.4 8.7 10.0		8.3 9.2 9.3	8.6	9.2 11.2 11.1	8.3	8.2	8.0 8.1 10.0	
D-3	-"-	3	5-10 10-20 30	8.6	8.6	8.4	8.3	8.6 8.6 9.1	8.9	9.5 9.5 9.4	8.6	8.5	8.4 8.5 8.6		9.4 10.0 9.8	8.7	9.4 11.0 11.0	8.6	8.6	8.1 8.2 8.6	
E-1	Ash + low moor peat + NPK	1	5-10 10-20 30	8.1	8.5	7.9	8.4	8.2 8.7 8.8	8.0	8.9 9.2 9.1	7.8	7.9	7.6 7.8 8.3		8.1 8.6 8.6	8.3	8.7 9.0 9.1	7.8	7.7	7.6 7.6 8.3	
E-2	-"-	2	5-10 10-20 30	8.2	8.6	8.1	8.3	8.3 8.5 8.7	8.4	8.7 9.0 8.5	7.8	8.0	7.6 8.1 8.2		8.2 8.5 8.7	8.4	9.0 8.6 8.5	8.0	7.8	7.6 7.9 8.2	
E-3	-"-	3	5-10 10-20 30	8.0	8.5	8.3	8.5	8.4 8.3 8.6	8.4	9.0 9.2 9.1	8.2	8.2	7.6 7.8 8.2		8.5 8.5 8.6	8.6	8.9 9.1 9.1	8.0	8.1	7.9 8.0 8.2	
F-1	Ash + high moor peat + NPK	1	5-10 10-20 30	8.5	8.8	8.4	8.4	8.6 8.7 8.7	8.5	8.6 9.2 9.3	8.3	8.2	8.0 8.3 8.4		8.6 8.7 8.6	8.4	8.9 9.3 9.3	8.2	8.2	8.1 8.3 8.4	
F-2	-"-	2	5-10 10-20 30	8.6	9.0	8.7	8.3	8.8 8.7 9.4	8.7	8.9 9.0 9.2	8.5	8.5	8.3 8.4 8.5		8.6 8.6 9.2	8.8	9.0 9.0 9.2	8.5	8.5	8.3 8.4 8.5	
F-3	-"-	3	5-10 10-20 30	8.7	8.8	8.5	8.5	8.8 8.9 9.3	8.8	8.9 9.1 9.4	8.5	8.4	8.3 8.4 8.5		8.8 8.8 9.3	8.9	9.1 9.1 9.4	8.6	8.4	8.4 8.5 8.5	
G-1	Ash + farm manure + NPK	1	5-10 10-20 30	8.7	9.0	8.7	8.5	8.7 8.8 9.0	8.8	9.0 9.1 9.3	8.5	8.5	8.3 8.4 8.6		8.6 8.7 9.4	8.8	9.0 9.2 9.3	8.5	8.5	8.1 8.2 8.6	
G-2	-"-	2	5-10 10-20 30	8.8	8.9	8.7	8.6	8.6 9.2 9.6	8.8	9.0 9.8 9.1	8.6	8.1	8.1 8.2 8.5		8.6 9.4 9.5	8.7	9.0 9.4 9.1	9.6	8.5	8.1 8.2 8.5	
G-3	-"-	3	5-10 10-20 30	8.7	8.8	8.4	8.4	8.4 8.8 9.1	8.6	8.9 9.3 9.4	8.5	8.4	8.1 8.6 8.7		8.6 8.6 9.1	8.9	9.0 9.1 9.4	8.4	8.2	8.1 8.2 8.7	
H-1	Ash + N2PK	1	5-10 10-20 30	8.5	8.7	8.2	7.8	8.4 8.4 8.9	8.6	8.9 9.0 9.0	8.3	8.0	7.8 8.0 8.1		8.4 8.5 8.6	8.9	8.7 8.8 9.0	9.2	8.4	7.8 8.0 8.1	
..	..																				

Table 43. Continued

1	2	3	4	5	6	7	8	9	10	11	12	131	14	15	16	17	18	19	20	21	22
H2	Ash + N2PK	2	5-10 10-20 30	8.5	8.6	8.3	8.5	8.3 9.1 10.2	8.2	8.3 9.0 9.2	8.2	8.0	7.9 7.9 8.0		8.5 8.5 9.5	8.7	8.7 9.0 9.2	8.1	8.0	7.8 7.9 8.0	
H-3	-"-	3	5-10 10-20 30	8.5	8.7	8.4	8.4	8.5 8.5 8.8	8.6	8.7 8.9 9.0	8.2	8.3	7.7 7.7 8.1		8.4 8.6 9.1	8.6	8.8 8.9 9.0	8.2	8.0	7.8 8.0 8.1	
I-1	Ash + NPK	1	5-10 10-20 30	8.8	9.3	8.8	8.5	8.7 8.7 9.3	8.9	9.0 9.5 9.8	8.6	8.7	8.0 8.3 8.3		9.1 9.7 10.1	8.8	9.6 9.8 9.8	8.7	8.8	8.6 8.6 8.3	
I-2	-"-	2	5-10 10-20 30	8.7	8.9	8.6	8.6	8.7 8.9 9.2	8.8	9.4 9.6 9.7	8.6	8.4	8.4 8.2 8.2		8.8 9.8 9.5	8.8	9.2 9.4 9.7	8.6	8.6	8.2 8.2 8.2	
I-3	-"-	3	5-10 10-20 30	8.7	8.8	8.6	8.7	8.6 8.7 8.8	8.7	9.0 9.2 9.1	8.6	8.4	7.8 8.1 8.3		8.3 8.3 8.8	8.9	8.8 9.3 9.1	8.5	8.1	7.9 7.9 8.3	
0-1	Ash withont fertilization till 1976 /control/	1	5-10 10-20 30	8.7	8.7	8.4	8.5	8.2 8.4 8.5	8.6	8.9 8.8 9.0	8.2	8.2	7.8 7.9 8.0		8.3 8.4 8.6	8.6	8.8 9.0 9.0	8.3	8.5	7.8 8.1 8.0	
0-2	-"-	2	5-10 10-20 30	8.7	8.8	8.4	8.6	8.4 8.5 9.0	8.6	8.7 8.9 8.9	8.1	8.0	7.6 8.0 8.1		8.3 8.4 8.5	8.5	8.7 9.0 8.9	8.2	8.1	7.6 7.9 8.1	
0-3	-"-	3	5-10 10-20 30	8.6	9.8	8.5	8.7	8.4 8.3 9.0	8.6	8.8 8.9 9.2	8.2	8.1	7.8 8.0 7.9		8.4 8.4 9.4	8.5	8.9 8.8 9.2	8.2	8.0	7.7 7.8 7.9	

Note: 1/ s = Spring
a = Fall

2/ Figures in col.3 denote cultivation of:

1 - lucerne with sweetclover
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Changes of pH reaction in produced ash soils
Konin

Table 44

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	measured value of pH in KCl																	
				fertilized plots											plots non-fertilized since 1977						
				1977		1978		1977		1978	1979		1980		1977		1978	1979		1980	
				s	e	s	a	s	a	s	s	a	s	a	s	a	s	s	a	s	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	7.7	7.8	7.3	7.8	7.5 8.1 9.0	8.1	8.0 10.2 9.6	7.6	7.1	7.5 7.3 7.8		8.1 8.4 9.0	8.3	8.5 8.6 9.6	7.6	7.8	7.4 7.3 7.8	
A-3	-"-	3	5-10 10-20 30	7.8	7.6	7.6	7.7	7.9 7.9 9.2	8.0	8.2 8.2 9.2	7.5	7.4	7.2 7.2 7.8		8.2 7.8 9.2	8.1	8.6 8.9 9.2	7.6	7.5	7.3 7.5 7.8	
A-4	-"-	4	5-10 10-20 30	7.7	7.7	7.9	7.9	7.8 8.6 9.0	8.1	8.3 8.6 9.2	7.9	7.6	7.4 7.5 7.9		8.4 8.3 9.0	8.1	8.6 8.5 9.2	7.7	7.7	7.6 7.8 7.9	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	8.2	8.3	7.8	7.9	8.4 8.4 9.2	8.0	8.6 9.1 9.5	7.9	7.7	7.6 7.9 8.0		8.6 8.6 9.2	8.4	9.0 9.1 9.5	7.9	7.7	7.8 7.9 8.0	
B-3	-"-	3	5-10 10-20 30	7.6	7.8	7.6	7.8	8.2 8.6 9.2	8.5	8.8 9.0 9.2	8.2	7.5	7.4 7.4 7.5		8.6 8.8 9.2	8.4	8.9 8.9 9.2	7.9	7.9	7.9 7.9 8.0	
B-4	-"-	4	5-10 10-20 30	8.0	7.8	7.8	8.3	8.3 8.4 9.3	8.3	8.7 9.3 9.6	7.7	7.8	7.6 7.9 8.1		8.5 8.4 9.3	8.2	9.2 9.4 9.6	8.2	8.2	7.5 7.5 8.1	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	8.2	7.9	7.8	7.6	8.4 8.5 8.9	8.4	9.1 9.3 10.2	8.4	7.9	8.0 8.0 7.9		8.6 8.8 8.9	8.3	9.0 9.0 10.2	8.0	8.3	7.8 8.0 7.9	
C-3	-"-	3	5-10 10-20 30	8.3	8.4	8.6	8.8	8.7 9.6 10.1	8.4	9.0 9.2 9.9	8.3	8.4	7.8 8.0 8.0		8.7 9.2 10.1	8.5	9.3 9.3 9.9	8.3	8.4	8.0 8.0 8.0	
C-4	-"-	4	5-10 10-20 30	8.4	8.4	8.0	8.5	8.5 8.9 9.2	8.5	9.2 9.5 10.1	8.3	8.0	7.8 7.9 8.0		8.6 8.8 9.2	8.1	9.1 9.0 10.1	8.4	8.4	9.0 8.0 9.0	

Table 44. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + tertiary sand + NPK	1	5-10 10-20 30	8.5	8.3	7.7	7.8	8.3 8.6 9.1	8.7	8.8 9.1 9.1	8.4	8.5	8.0 8.1 7.9		8.3 8.4 9.1	7.7	9.1 9.3 9.1	8.5	8.4	8.3 8.2 7.9	
D-2	-"-	2	5-10 10-20 30	8.5	8.0	8.3	7.7	8.5 8.8 9.5	8.5	8.8 8.9 9.2	8.4	8.1	8.2 8.1 8.2		8.5 8.8 9.5	8.4	8.2 8.9 9.2	8.5	8.4	8.3 8.1 8.2	
D-3	-"-	3	5-10 10-20 30	8.8	8.3	8.4	8.2	8.5 8.9 9.6	8.6	7.7 8.8 9.5	8.5	7.8	8.3 8.2 8.5		8.1 8.5 9.6	8.4	9.1 9.6 9.5	8.0	8.2	8.3 8.4 8.5	
E-1	Ash + low moor peat + NPK	1	5-10 10-20 30	8.6	8.9	8.5	8.6	8.6 8.8 9.6	8.5	9.4 9.5 10.6	8.3	8.3	7.8 7.8 7.9		8.6 8.9 9.6	8.7	8.9 9.4 10.6	8.3	8.3	7.8 7.9 7.9	
E-2	-"-	2	5-10 10-20 30	8.5	8.6	8.5	8.4	8.7 9.0 9.3	8.8	9.1 9.8 10.1	8.4	8.2	7.8 7.9 8.2		8.6 9.0 9.3	8.6	9.5 9.9 10.1	8.3	8.2	7.9 7.7 8.2	
E-3	-"-	3	5-10 10-20 30	8.5	8.7	8.6	8.6	8.5 9.4 9.2	8.6	9.3 9.6 10.1	8.4	8.3	7.9 8.0 8.2		8.6 9.3 9.2	8.6	9.3 9.8 10.1	8.2	8.3	8.0 8.0 8.2	-
F-1	Ash + high moor peat + NPK	1	5-10 10-20 30	8.5	8.7	8.5	8.5	8.7 9.6 9.5	8.6	9.2 9.6 10.4	8.3	8.3	7.9 7.9 8.2		8.6 9.2 9.5	8.5	9.4 9.7 10.4	8.2	8.2	7.9 7.9 8.2	
F-2	-"-	2	5-10 10-20 30	8.7	8.8	8.5	8.5	8.7 9.1 9.5	8.6	9.4 9.6 10.0	8.5	8.2	7.8 7.8 8.1		8.6 9.4 9.5	8.6	9.3 9.8 10.0	8.4	8.4	7.8 7.9 8.1	
F-3	-"-	3	5-10 10-20 30	8.6	8.6	8.5	8.5	8.7 9.1 9.0	8.6	9.4 10.2 10.1	8.2	8.3	7.9 8.1 8.2		8.7 9.3 9.0	8.5	9.6 9.7 10.1	8.2	8.2	8.0 8.0 8.2	
G-1	Ash + farm manure + NPK	1	5-10 10-20 30	8.8	8.9	8.7	8.6	8.7 9.0 9.0	8.6	9.2 9.4 9.6	8.3	8.3	8.0 8.1 8.2		8.6 9.0 9.0	8.5	9.1 9.2 9.6	8.3	8.2	7.9 8.0 8.2	
G-2	-"-	2	5-10 10-20 30	8.5	8.6	8.7	8.5	8.6 9.0 9.8	8.7	9.3 9.8 10.6	8.4	8.2	7.9 8.0 8.1		8.7 9.5 9.8	8.6	9.3 9.6 10.6	8.5	8.4	8.0 8.0 8.1	
G-3	-"-	3	5-10 10-20 30	8.6	9.3	8.6	8.4	8.7 9.0 9.1	8.7	9.2 9.6 10.4	8.2	8.3	8.0 7.9 8.2		8.7 9.1 9.1	8.4	9.4 9.4 10.4	8.3	8.2	8.1 7.9 8.2	
H/K/-1	Ash + N2PK + green manure /corn/	1	5-10 10-20 30	8.6	8.6	8.6	8.6	8.6 8.8 9.3	8.5	9.3 9.9 10.7	8.2	8.2	7.8 8.0 8.2		8.4 8.9 9.3	8.4	9.3 9.3 10.7	8.1	8.2	8.1 7.9 8.2	
H/K/-2	-"-	2	5-10 10-20 30	8.7	8.8	8.5	8.6	8.6 8.6 8.6	8.5	9.1 9.5 10.3	8.3	8.2	7.9 7.8 8.1		8.6 9.3 8.6	8.6	9.4 9.6 10.3	8.4	8.3	7.9 7.9 8.1	

Table 44. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
H/K/-3	Ash + N2PK + green manure /corn/	3	5-10 10-20 30	8,7	8.5	8.5	8.5	8.5 9.0 9.1	8.5	9.1 9.3 9.7	8.3	8.4	7.9 7.7 8.3		8.6 9.0 9.1	8.4	9.1 9.3 9.7	8.2	8.1	7.8 7.8 8.3	
I-1	Ash + NPK	1	5-10 10-20 30	8.7	8.7	8.4	8.5	8.5 9.0 10.0	8.6	9.4 9.8 10.4	8.4	8.3	7.9 7.9 7.9		8.7 8.7 10.0	8.4	9.3 9.5 10.4	8.4	8.4	7.8 7.9 7.9	
I-2	-"-	2	5-10 10-20 30	8.7	8.8	8.4	8.6	8.5 8.8 9.4	8.6	9.2 9.6 10.5	8.3	8.3	8.2 8.0 8.4		8.6 9.2 9.4	8.6	9.5 9.5 10.5	8.2	8.3	7.9 8.1 8.4	
I-3	-"-	3	5-10 10-20 30	8.8	8.7	8.6	8.5	8.5 9.0 9.2	8.5	9.3 10.0 9.9	8.3	8.3	8.1 8.2 8.2		8.6 9.2 9.2	8.5	9.3 10.0 9.9	8.5	8.3	8.2 8.3 8.2	
0-1	Ash withont fertilization till 1976 /control/	1	5-10 10-20 30	8.5	8.5	8.7	8.5	8.6 9.0 9.5	8.6	9.0 9.3 10.2	8.3	8.3	9.4 8.3 8.3		8.5 9.0 9.5	8.6	9.1 9.7 10.2	8.2	8.3	8.2 8.4 8.3	
0-2	-"-	2	5-10 10-20 30	8.6	8.7	8.6	8.6	8.6 9.0 9.1	8.8	9.1 10.4 10.5	8.3	8.3	8.2 8.2 8.7		8.6 9.5 9.1	8.6	9.3 9.9 10.5	8.4	8.2	8.2 8.4 8.7	
0-3	-"-	3	5-10 10-20 30	8.8	8.4	8.5	8.6	8.6 9.3 9.2	8.5	9.3 9.6 10.0	8.2	8.2	8.0 8.1 8.2		8.6 9.2 9.2	8.4	9.2 9.5 10.0	8.2	8.2	8.2 8.2 8.2	

Note: 1/ s = Spring
a = Fall

2/ Figures in col.3 denote cultivation of:
-1- sainfoin wish crown vetch
-2- mixture of grasses with legumes
-3- lucerne with orchard grass
-4- sweetclover

Content of $CaCO_3$ in produced ash soils [percent]
Halemba

Table 45

No. of plot	Combinations of soils and fertilizers	No. of mix-ture	Sampl-ing depth cm	Measured content of $CaCO_3$																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	0.33	0.33	0.25	0.16 2.94	0.16 0.16	0.33	0.08 0.12 1.28	0.25	0.41	0.16 0.16 0.16		0.16 0.08 1.89	0.33	0.08 0.42 1.28	0.16	0.33	0.08 0.25	
A-3	"	3	5-10 10-20 30	0.16	0.33	0.25	0.16	0.08 0.16 2.73	0.25	0.08 0.12 1.32	0.16	0.25	0.08 0.33 1.47		0.16 0.25 1.68	0.33	0.08 0.12 1.62	0.16	0.33	0.16 033	
A-4	"	4	5-10 10-20 30	0.25	0.24	0.16	0.16	0.13 0.25 0.57	0.25	0.17 0.93 1.70	0.26	0.25	0.16 0.16 2.10		0.16 0.16 2.52	0.42	0.42 1.11 1.70	0.25	0.25	0.16 0.08	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	0.16	0.24	0.16	0.16	0.16 0-25 2.52	0.33	0.33 0.68 1.19	0.33	0.41	1.11 2.69 0.16		0.33 1.68 2.52	0.42	0.33 1.87 1.19	0.25	0.33	1.34 0.25	
B-3	"	3	5-10 10-20 30	0.33	0.24	0.16	0.16	1.34 0.13 0.52	0.25	0.33 0.42 2.99	0.25	0.41	1.09 2.19 0.16		0.16 0.42 3.36	0.42	0.12 1.62 2.99	0.50	0.25	0.92 0.16	
B-4	"	4.	5-10 10-20 30	0.25	0.24	0.25	0.16	0.25 2.43 1.93	0.42	0.38 4.52 2.90	0.16	0.33	2.10 1.34 1.33		0.16 0.92 4.36	0.59	0.17 0.64 2.90	0.41	0.75	0.33 0.25	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	0.16	1.57	1.86	1.52	0.92 3.27 2.26	2.54	0.85 3.07 2.00	2.01	1.00	1.43 3.37 3.43		2.52 0.25 3.36	1.35	0.42 4.01 2.00	0.50	4.55	0.33 1.34	
C-3	"	3	5-10 10-20 30	0.76	1.07	1.18	0.33	2.68 4.36 3.10	4.32	3.93 4.27 3.24	3.77	2.48	2.79 6.00 5.22		2.68 3.52 3.65	2.80	0.76 4.78 3.24	0.25	0.91	2.69 5.89	
C-4	"	4	5-10 10-20 30	1.26	1.82	1.94	0.84	2.94 6.21 3.61	7.42	5.46 2.99 1.36	0.54	4.80	4.55 5.47 5.09		5.29 6.30 3.52	3.13	4.95 7.00 1.36	3.35	0.99	2.69 5.90	

Table 45. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5-10	2.28	3.89	1.77	1.95	6.63	6.15	5.04	3.10	0.49	6.06		1.76	3.98	1.36	5.03	4.55	2.61	
			10-20					3.61		3.33			6.31		2.43		2.13			2.94	
			30					7.72		2.39			6.40		2.62		2.39				
D-2	"	2	5-10	2.36	3.72	2.36	1.52	6.04	4.80	5.66	9.40	8.11	9.43		2.68	4.41	3.41	3.52	3.64	3.11	
			10-20					3.62		2.05			7.24		3.44		2.64			2.94	
			30					4.20		1.62			7.41		2.52		1.62				
D-3	"	3	5-10	3.72	3.89	3.80	2.12	3.69	3.90	5.46	6.80	6.87	5.56		5.20	3.60	6.15	5.62	7.20	4.71	
			10-20					4.36		4.27			5.89		5.29		4.27			5.56	
			30					2.68		2.73			4.80		5.52		2.73				
E-1	Ash + low moor peat + NPK	1	5-10	1.77	1.98	1.26	1.95	2.53	1.27	1.19	1.51	2.07	1.01		0.50	1.78	1.20	1.25	1.82	0.50,	
			10-20					7.73		1.53			1.09		3.97		1.64				
			30					5.15		1.16			1.43		2.96		1.16				
E-2	"	2	5-10	2.29	1.15	1.43	2.03	3.04	1.69	1.36	1.42	2.23	1.68		2.79	1.95	1.27	1.34	1.90	1.43	
			10-20					3.32		1.44			2.19		4.39		0.93			2.94	
			30					5.68		0.76			2.02		4.73		0.76				
E-3	"	3	5-10	2.71	2.40	2.28	2.03	4.73	3.39	1.87	2.09	2.57	0.92		2.62	2.29	1.61	1.84	2.07	1.51	
			10-20					3.80		2.04			1.01		2.73		2.04				
			30																		
F-1	Ash + high moor peat + NPK	1	5-10	3.22	3.14	1.60	1.86	2.02	2.63	2.01	2.63	2.55	2.51		2.19	1.36	1.04	1.84	2.48	2.19	
			10-20					2.11		2.71			2.61		6.00		1.53			2.35	
			30					2.13		1.87			2.69		6.00		1.87				
F-2	"	2	5-10	3.98	4.63	3.97	2.20	4.39	4.45	3.32	3.52	4.06	3.87		2.87	7.42	2.89	3.27	3.39	2.94	
			10-20					2.28		2.29			3.58		2.70		2.21			3.11	
			30					2.79		2.04			3.79		2.70		2.04				
F-3	"	3	5-10	4.39	3.80	2.53	2.88	5.79	5.51	4.25	3.10	4.14	4.46		4.31	4.87	4.76	5.20	4.47	5.89	
			10-20					5.19		3.74			5.55		3.38		3.91			5.22	
			30					2.19		1.78			4.38		2.36		2.32				
G-1	Ash + farm manure + NPK	1	5-10	6.08	5.96	5.15	3.22	4.73	6.15	3.91	4.28	5.97	4.38		3.29	4.32	3.23	3.44	4.31	4.31	
			10-20					3.55		3.49			5.05		3.38		3.66			4.38	
			30					2.53		2.38			4.85		1.86		2.38				
G-2	"	2	5-10	6.08	6.53	4.39	3.05	3.89	5.57	3.23	5.20	2.07	3.45		3.89	3.60	3.32	5.62	6.30	4.20	
			10-20					5.58		3.40			5.47		5.07		4.68			3.79	
			30					2.96		3.91			6.90		3.38		3.91				
G-3	"	3	5-10	4.05	4.13	4.05	3.05	3.21	3.13	3.75	4.78	6.05	4.38		3.04	5.09	4.87	3.94	3.81	5.53	
			10-20					2.62		3.16			2.77		2.87		3.16			5.03	
			30					2.87		3.14			4.46		2.11		3.14				
H-1	Ash + N2PK	1	5-10	3.13	3.06	1.69	1.61	2.11	1.48	2.05	1.76	2.07	1.01		1.52	4.66	2.05	1.51	4.47	1.51	
			10-20					2.11		1.96			1.85		1.69		1.70			1.76	
			30					1.77		2.13			1.68		1.69		2.13				
H-2	"	2	5-10	1.94	2.56	1.36	1.35	2.19	2.12	2.05	1.76	2.81	1.68		2.70	1.78	1.62	1.25	2.15	1.43	
			10-20					2.02		1.96			2.10		2.53		2.05			1.76	
			30					3.97		4.18			2.27		4.22		4.18				
H-3	"	3	5-10	2.11	2.89	2.62	1.61	2.11	3.47	1.70	1.34	3.89	1.85		1.77	2.54	1.96	2.01	2.23	1.68	
			10-20					1.86		1.87			2.10		1.69		2.30			1.43	
			30					2.19		1.19			1.85		2.70		1.19				

Table 45. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10 10-20 30	4.31	7.11	7.35	3.05	3.94 4.62 2.26	5.17	3.84 3.93 2.56	4.28	7.28	4.24 1.58 2.60		6.97 5.20 1.76	6.87	7.26 3.24 2.56	6.46	2.43	7.04 7.21	
I-2	"	2	5-10 10-20 30	4.90	7.28	5.41	2.63	3.86 2.60 2.68	3.47	4.69 3.84 3.53	4.08	4.72	3.39 3.81 5.42		6.46 4.78 1.68	5.94	3.67 4.27 3.33	5.12	8.70	5.76 2.96	
I-3	"	3	5-10 10-20 30	6.08	5.96	6.59	4.58	2.60 3.19 1.84	2.96	2.64 2.64 2.47	5.20	5.88	2.37 2.37 2.40		2.18 2.35 2.26	3.47	3.67 2.47 2.47	4.11	3.48	2.12 1.44	
O-1	Ash without fertilization till 1976 (control)	1	5-10 10-20 30	3.89	3.47	3.21	2.63	1.76 1.26 1.42	4.07	1.70 1.62 2.22	2.18	2.48	1.18 1.63 2.29		1.76 1.68 1.68	6.36	2.56 1.36 2.22	3.44	4.89	3.13 1.43	
O-2	"	2	5-10 10-20 30	4.07	2.98	2.35	1.69	1.69 1.43 2.45	2.33	1.87 2.73 0.68	1.42	2.15	2.08 2.79 2.29		1.69 1.52 1.09	2.12	1.36 1.45 0.68	2.81	1.35	1.35 1.76	
O-3	"	3	5-10 10-20 30	4.05	3.72	5.24	3.39	2.26 2.18 2.68	2.12	3.93 2.90 1.87	2.26	3.39	2.96 2.05 2.01		2.60 1.26 1.52	2.03	2.56 1.70 1.87	1.59	2.32	2.03 2.20	

Note: 1) S - Spring
a - Fall
2) Figures in col. 3
denote cultivation of:
1 - lucerne with
sweetclover
2 - mixture of grasses
with legumes
3 - lucerne with orchard
grass
4 - sweetclover

Content of $CaCO_3$ [percent] in produced ash soils
Konin

Table 46

No. of plot	Combinations of soils and fertilizers	No. of mix-ture	Sampl-ing depth cm	Measured content of $CaCO_3$ [percent]																	
				Fertilized plots											Plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5–10 10–20 30	1.01	0.42	0.76	1.10	0.92 0.67 5.26	1.10	0.48 7.72 5.51	0.75	0.91	0.58 0.67 3.45		1.68 2.35 5.26	1.86	0.76 1.10 5.51	1.34	2.16	0.58 0.84	–
A-3	"	3	5–10 10–20 30	1.01	1.01	0.84	0.93	1.26 1.26 8.00	1.18	0.67 0.67 5.51	0.83	1.00	0.67 0.84 3.96		0.75 1.43 8.00	1.65	1.35 3.22 5.51	1.17	1.25	1.01 1.60	
A-4	"	4	5–10 10–20 30	1.43	1.01	1.09	1.01	1.17 5.05 8.63	1.52	1.01 1.35 6.36	1.84	1.66	1.01 0.50 7.75		1.26 4.42 8.63	1.86	0.84 0.93 6.36	1.25	1.91	2.02 1.68	
B-2	Ash + 10 cm of fertile soil + NPK	2	5–10 10–20 30	1.69	2.69	1.01	1.78	2.94 4.42 5.31	1.18	7.97 6.70 3.39	1.09	1.50	1.34 1.76 4.38		3.79 10.53 5.31	3.10	4.24 1.95 3.39	1.25	1.16	1.85 6.99	
B-3	"	3	5–10 10–20 30	1.26	1.17	1.09	1.35	1.68 8.84 7.37	5.30	2.93 5.17 4.24	1.50	1.01	1.01 0.92 1.85		10.11 9.47 7.37	2.89	8.05 2.03 4.24	1.42	2.25	9.69 11.54	
B-4	"	4	5–10 10–20 30	1.18	1.01	1.01	2.63	1.34 2.52 10.32	1.95	7.63 7.30 4.24	0.83	2.41	2.69 4.46 9.10		1.76 5.10 10.32	2.07	8.99 7.04 4.24	3.10	3.25	1.09 0.92	
C-2	Ash + 5 cm of fertile soil + NPK	2	5–10 10–20 30	1.18	1.76	0.25	1.78	1.09 5.74 5.47	3.60	7.12 5.76 6.19	8.73	2.66	7.24 8.00 1.03		5.26 7.58 5.47	2.27	2.63 6.95 5.19	1.59	5.83	2.52 7.75	
C-3	"	3	5–10 10–20 30	1.86	4.84	2.63	5.68	4.69 7.68 7.26	4.66	6.10 8.48 6.95	3.94	9.84	3.45 8.84 9.01		2.56 7.90 7.26	4.76	7.97 10.35 6.95	5.45	7.92	8.84 5.30	
C-4	"	4	5–10 10–20 30	1.01	2.69	0.84	2.20	3.20 7.47 7.90	15.93	12.30 8.90 8.48	15.32	2.66	1.17 3.45 10.02		6.62 8.97 7.90	1.86	7.89 7.97 8.48	9.65	7.25	9.43 13.40	
..	.. .																				

Table 46. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + tertiary sand + NPK	1	5-10 10-20 30	1.16	1.85	0.42	0.33	4.05 7.04 7.68	4.55	0.67 3.90 4.32	11.33	5.67	1.76 5.14 8.34		0.59 4.48 7.68	1.24	8.31 7.80 4.32	11.33	7.34	11.33 10.42	
D-2	"	2	5-10 10-20 30	4.05	0.58	2.28	0.42	3.63 7.90 6.62	9.31	6.02 9.33 6.70	5.37	2.08	11.25 13.84 11.25		1.49 5.55 6.62	2.89	2.63 7.63 6.70	4.70	5.25	12.55 14.34	
D-3	"	3	5-10 10-20 30	4.35	1.09	1.35	0.93	5.34 12.17 12.17	6.62	0.76 5.93 4.75	6.88	2.66	6.33 11.67 12.00		1.11 4.48 12.17	1.44	3.30 6.27 4.75	0.67	3.16	10.67 9.17	
E-1	Ash + low moor peat + NPK	1	5-10 10-20 30	13.93	17.06	15.64	10.24	17.94 14.93 12.81	16.56	14.09 11.32 8.97	18.05	21.68	6.62 6.88 8.48		18.79 16.23 12.81	20.22	14.31 13.24 8.97	19.73	17.35	8.14 10.16	
E-2	"	2	5-10 10-20 30	12.00	18.12	16.70	17.64	18.36 14.09 10.89	17.18	13.67 12.60 11.96	19.81	21.48	9.66 10.33 11.39		19.22 13.24 10.89	17.72	15.59 16.44 11.96	17.63	21.89	9.57 9.15	
E-3	"	3	5-10 10-20 30	12.00	16.85	17.12	18.48	19.01 15.37 15.16	16.78	13.88 11.53 10.03	19.10	20.86	7.98 8.36 7.81		17.12 16.02 15.16	19.60	12.38 8.79 10.03	19.94	18.17	6.55 5.96	
F-1	Ash + high moor peat + NPK	1	5-10 10-20 30	12.00	17.27	13.95	16.17	17.08 13.88 14.52	15.93	12.81 12.60 10.89	17.42	21.27	11.92 12.98 12.26		12.81 11.53 14.52	16.05	14.93 10.89 10.89	17.42	20.86	11.59 5.12	
F-2	"	2	5-10 10-20 30	13.08	16.64	15.64	17.01	20.07 15.30 15.19	18.42	10.68 9.18 5.83	18.47	22.10	10.08 11.34 10.66		14.73 14.31 15.16	10.76	15.80 12.38 6.83	17.84	18.17	10.83 11.08	
F-3	"	3	5-10 10-20 30	14.58	15.80	15.85	12.05	11.32 13.24 12.81	15.52	12.81 10.25 13.02	17.63	21.06	10.16 10.92 10.75		14.93 15.16 12.81	18.63	12.38 12.38 13.02	19.73	21.48	9.66 9.81	
G-1	Ash + farm manure + NPK	1	5-10 10-20 30	15.22	13.69	16.48	15.33	16.44 14.31 15.37	15.52	12.35 11.96 10.68	16.58	18.17	13.20 14.33 11.39		18.36 14.09 15.37	19.04	13.24 11.53 10.68	21.40	21.48	10.50 9.91	
G-2	"	2	5-10 10-20 30	17.37	17.90	17.12	8.65	17.08 16.23 13.88	15.73	13.02 11.74 12.81	16.79	17.35	10.38 9.63 11.21		16.23 14.91 13.88	18.63	9.61 10.68 12.81	16.37	19.00	13.79 12.04	
G-3	"	3	5-10 10-20 30	15.22	16.22	15.00	10.01	16.02 14.93 13.26	12.83	12.60 11.10 10.48	20.57	17.96	13.79 15.36 12.04		16.02 16.02 13.26	17.80	14.09 13.67 10.48	18.26	16.52	13.29 9.55	
H(K)-1	Ash + N2PK + green manure (corn)	1	5-10 10-20 30	16.51	22.75	11.33	17.22	22.64 19.43 19.43	16.76	13.85 11.74 21.81	18.47	21.48	15.81 15.20 14.33		18.36 16.44 19.43	19.25	18.87 19.01 12.81	24.34	21.89	13.63 13.37	
H(K)-2	"	2	5-10 10-20 30	1677	17.90	18.39	18.06	14.95 13.67 18.15	13.24	13.85 13.64 11.70	20.36	22.72	13.04 12.87 13.70		17.51 16.87 18.15	22.35	13.43 12.47 11.70	17.42	19.41	13.20 14.37	
H(K)-3	"	3	5-10 10-20 30	17.37	18.96	23.25	17.22	20.07 19.43 17.37	14.69	12.53 12.30 13.43	20.38	29.74	16.03 17.81 16.20		15.59 15.80 17.30	16.97	16.79 17.84 13.43	20.15	20.03	15.86 14.28	
..	. ..																				

Table 46. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10 10-20 30	16.29	18.75	17.75	18.27	18.36 19.86 28.83	17.18	10.35 11.19 20.36	19.52	22.30	13.95 14.20 15.03		16.02 20.93 28.83	25.46	17.00 10.29 20.36	24.13	18.17	13.37 13.95	
I-2	"	2	5-10 10-20 30	14.15	19.38	15.00	16.38	18.36 16.44 16.66	17.80	10.77 10.35 8.39	19.10	19.82	15.12 14.28 12.96		19.65 16.87 16.66	23.18	10.33 10.18 8.39	19.10	20.65	16.61 12.12	
I-3	"	3	5-10 10-20 30	14.15	19.38	15.85	16.38	17.94 14.93 15.16	21.32	11.45 10.35 10.52	19.31	22.30	10.00 9.67 12.09		20.07 16.66 15.16	21.73	11.53 9.41 10.52	20.15	22.51	13.79 14.45	
0-1	Ash without fertilization till 1976 (control)	1	5-10 10-20 30	5.75	12.22	10.78	8.65	7.90 7.47 6.19	23.66	8.73 10.09 7.80	9.65	15.90	15.00 10.08 10.92		9.61 10.03 6.19	14.49	10.35 9.07 7.80	12.15	14.66	11.83 10.42	
0-2	"	2	5-10 10,20 30	7.07	14.11	10.35	10.86	19.86 19.65 7.90	19.45	11.79 7.12 9.07	6.80	19.12	18.01 18.26 14.34		21.36 17.94 7.90	13.24	10.43 10.01 9.07	13.85	20.86	16.25	
0-3	"	3	5-10 10-20 30	17.79	23.38	15.00	11.96	17.51 14.95 20.07	18.00	9.67 10.01 10.52	17.63	18.38	4.00 7.92 11.33		15.37 13.45 20.07	21.94	11.62 11.19 10.52	20.03	23.13	12.00 15.50	

Note: 1) S - Spring
a - Fall

2) Figures in col. 3 denote cultivation of:

1 - sainfoin with crown vetch
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Salinity of produced ash soils
Halemba

Table 47

No. of plot	Combinations of soils and fertilizers	No. of mix-ture	Sampl-ing depth cm	Measured salinity [g NaCl/dm³ of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5–10 10–20 30	0.57	0.24		0.15	0.15 0.09 0.30	0.18	0.12 0.03 0.21	0.15	0.27	0.21 0.15 0.18		0.09 0.09 0.24	0.12	0.05 0.24 0.21	0.15	0.21	0.05 0.21 0.18	
A-3	"	3	5–10 10–20 30	0.57	0.23		0.09	0.15 0.18 0.39	0.09	0.05 0.05 0.30	0.15	0.18	0.05 0.15 0.05		0.09 0.09 0.36	0.09	0.05 0.05 0.30	0.15	0.21	0.05 0.05 0.05	
A-4	"	4	5–10 10–20 30	0.78	0.20		0.09	0.09 0.12 0.27	0.12	0.05 0.30 0.24	0.15	0.21	0.27 0.57 0.18		0.12 0.15 0.37	0.27	0.24 0.21 0.24	0.15	0.15	0.18 0.05 0.18	
B-2	Ash + 10 cm of fertile soil + NPK	2	5–10 10–20 30	0.87	0.33		0.15	0.12 0.15 0.27	0.12	0.24 0.18 0.24	0.15	0.21	0.15 0.54 0.45		0.33 0.45 0.36	0.21	0.21 0.39 0.24	0.15	0.18	0.05 0.25 0.45	
B-3	"	3	5–10 10–20 30	0.78	0.21		0.15	0.66 0.27 0.36	0.12	0.18 0.18 0.30	0.15	0.33	0.05 0.51 0.48		0.09 0.36 0.42	0.30	0.05 0.30 0.30	0.15	0.18	0.15 0.39 0.48	
B-4	"	4	5–10 10–20 30	0.93	0.26		0.24	0.24 0.48 0.39	0.42	0.24 0.39 0.30	0.15	0.21	0.18 0.39 0.42		0.18 0.60 0.45	0.42	0.05 0.39 0.30	0.15	0.18	0.15 0.39 0.42	
C-2	Ash + 5 cm of fertile soil + NPK	2	9–10 10–20 30	0.78	0.48		0.18	0.42 0.36 0.36	0.48	0.24 0.24 0.24	0.21	0.36	0.36 0.42 0.48		0.39 0.24 0.42	0.42	0.24 0.30 0.24	0.18	0.39	0.42 0.42 0.48	
C-3	"	3	5–10 10–20 30	0.78	0.36		0.12	0.39 1.08 1.05	0.51	0.30 0.36 0.60	0.27	0.54	0.45 0.36 0.51		0.42 0.45 1.50	0.36	0.24 0.30 0.60	0.18	0.33	0.30 0.36 0.51	
C-4	"	4	5–10 10–20 30	1.02	0.30		0.09	0.36 0.60 0.54	0.75	0.30 0.72 0.66	0.39	0.51	0.57 0.48 0.51		0.42 0.90 0.36	0.39	0.30 0.33 0.66	0.30	0.33	0.30 0.36 0.51	
..	.. .																				

Table 47. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5-10 10-20 30	0.65	0.26		0.12	0.42 1.08 0.54	0.51	0.30 0.57 0.66	0.24	0.39	0.48 0.48 0.51		0.24 0.24 0.36	0.27	0.24 0.24 0.66	0.24	0.30	0.24 0.27 0.51	
D-2	"	2	5-10 10-20 30	0.66	0.27		0.12	0.99 1.11 1.17	0.99	0.45 0.72 0.78	0.33	0.51	0.39 0.66 0.78		0.36 1.71 1.80	0.33	0.21 0.84 0.78	0.42	0.27	0.33 0.27 0.78	
D-3	"	3	5-10 10-20 30	0.63	0.26		0.15	0.54 0.69 1.86	0.39	0.30 0.30 0.24	0.18	0.76	0.45 0.48 0.42		0.45 1.44 1.08	0.33	0.24 0.54 0.24	0.36	0.36	0.36 0.57 0.42	
E-1	Ash + low moor peat + NPK	1	5-10 10-20 30	0.45	0.26		0.15	0.24 0.36 0.36	0.24	0.21 0.24 0.24	0.21	0.24	0.30 0.39 0.57		0.33 0.36 0.36	0.27	0.24 0.24 0.24	0.15	0.27	0.33 0.30 0.57	
E-2	"	2	5-10 10-20 30	0.39	0.26		0.21	0.27 0.24 0.33	0.33	0.18 0.21 0.24	0.18	0.73	0.42 0.51 0.66		0.27 0.27 0.36	0.27	0.18 0.18 0.24	0.18	0.24	0.36 0.27 0.66	
E-3	"	3	5-10 10-20 30	0.45	0.29		0.15	0.27 0.24 0.24	0.30	0.21 0.21 0.24	0.18	0.21	0.48 0.50 0.78		0.27 0.24 0.24	0.30	0.21 0.21 0.24	0.15	0.21	0.50 0.33 0.78	
F-1	Ash + high moor peat + NPK	1	5-10 10-20 30	0.39	0.23		0.15	0.36 0.33 0.33	0.36	0.24 0.24 0.24	0.27	0.24	0.57 0.48 0.51		0.36 0.24 0.33	0.24	0.18 0.24 0.24	0.15	0.24	0.36 0.27 0.51	
F-2	"	2	5-10 10-20 30	0.30	0.42		0.18	0.54 0.54 0.81	0.42	0.30 0.45 0.54	0.27	0.30	0.36 0.46 0.48		0.36 0.33 0.69	0.39	0.24 0.21 0.54	0.18	0.21	0.33 0.36 0.48	
F-3	"	3	5-10 10-20 30	0.45	0.29		0.18	0.42 0.42 0.42	0.45	0.24 0.30 0.27	0.15	0.24	0.45 0.51 0.51		0.36 0.36 0.54	0.33	0.24 0.24 0.27	0.24	0.24	0.39 0.24 0.51	
G-1	Ash + farm manure + NPK	1	5-10 10-20 30	0.45	0.33		0.18	0.36 0.36 0.36	0.45	0.24 0.24 0.21	0.24	0.33	0.30 0.42 0.51		0.33 0.33 1.38	0.36	0.24 0.24 0.21	0.18	0.27	0.30 0.40 0.51	
G-2	"	2	5-10 10-20 30	0.51	0.32		0.24	0.36 0.87 1.35	0.39	0.24 0.39 0.24	0.21	0.21	0.96 0.93 0.84		0.36 0.78 0.99	0.27	0.30 0.18 0.24	0.27	0.24	0.30 0.93 0.84	
G-3	"	3	5-10 10-20 30	0.57	0.30		0.18	0.36 0.36 0.54	0.36	0.21 0.24 0.24	0.27	0.33	0.39 0.51 0.51		0.27 0.27 0.84	0.39	0.24 0.24 0.24	0.15	0.21	0.27 0.30 0.51	
H-1	Ash + N2PK	1	5-10 10-20 30	0.51	0.24		0.15	0.27 0.27 0.36	0.33	0.18 0.18 0.21	0.27	0.21	0.42 0.36 0.42		0.24 0.24 0.24	0.33	0.18 0.15 0.21	0.15	0.24	0.30 0.36 0.42	
H-2	"	2	5-10 10-20 30	0.45	0.24		0.12	0.33 0.45 1.41	0.24	0.18 0.21 0.24	0.24	0.24	0.36 0.45 0.32		0.36 0.33 0.99	0.30	0.15 0.18 0.24	0.15	0.21	0.27 0.27 0.36	
H-3	"	3	5-10 10-20 30	0.57	0.30		0.15	0.30 0.27 0.36	0.30	0.18 0.18 0.21	0.18	0.24	0.36 0.39 0.36		0.27 0.27 0.93	0.27	0.18 0.24 0.21	0.15	0.21	0.30 0.33 0.36	

Table 47. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10	0.45	0.51		0.18	0.45	0.39	0.24	0.30	0.45	0.45		0.63	0.39	0.39	0.24	0.48	0.48	
			10-20					0.45		0.30			0.54		0.99		0.39			0.42	
			30					1.44		0.81			0.48		1.26		0.81			0.48	
I-2	"	2	5-10	0.45	0.44		0.15	0.60	0.33	0.24	0.30	0.30	0.36		0.51	0.39	0.24	0.24	0.33	0.39	
			10-20					0.45		0.30			0.42		0.78		0.27			0.39	
			30					1.38		0.54			0.48		1.08		0.54			0.48	
I-3	"	3	5-10	0.57	0.36		0.21	0.36	0.33	0.24	0.27	0.27	0.54		0.24	0.39	0.21	0.18	0.27	0.36	
			10-20					0.36		0.24			0.54		0.24		0.24			0.21	
			30					0.33		0.24			0.48		0.54		0.24			0.48	
0-1	Ash without fertilization till 1976 (control)	1	5-10	0.36	0.30		0.15	0.24	0.30	0.24	0.18	0.36	0.60		0.24	0.33	0.21	0.24	0.33	0.28	
			10-20					0.27		0.24					0.27		0.21				
			30					0.27		0.24					0.27		0.24				
0-2	"	2	5-10	0.30	0.32		0.27	0.30	0.30	0.18	0.27	0.30	0.39		0.36	0.27	0.18	0.15	0.24	0.27	
			10-20					0.27		0.18			0.45		0.33		0.18			0.45	
			30					0.63		0.21			0.51		0.27		0.21			0.51	
0-3	"	3	5-10	0.36	0.29		0.21	0.24	0.30	0.24	0.27	0.36	0.27		0.27	0.24	0.18	0.18	0.27	0.39	
			10-20					0.27		0.18			0.33		0.24		0.18			0.24	-
			30					0.69		0.21			0.39		1.17		0.21			0.39	

Note: 1) S = Spring
8 = Fall
2) Figures in col. 3 denote cultivation of:
1 - lucerne with sweetclover
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Salinity of produced ash soils
Konin

Table 48

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured salinity [g NaCl/dm³ of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	1.38	0.75		0.51	0.18 0.18 2.22	0.18	0.15 2.25 1.50	0.15	0.51	0.21 0.21 0.66		0.66 0.66 2.22	0.27	0.36 0.24 1.50	0.15	0.30	0.27 0.24 0.66	
A-3	"	3	5-10 10-20 30	0.81	0.68		0.24	0.24 0.24 2.85	0.18	0.12 0.15 1.68	0.15	0.24	0.30 0.27 1.83		0.51 0.24 2.85	0.24	0.30 0.36 1.68	0.24	0.24	0.45 0.51 1.83	
A-4	"	4	5-10 10-20 30	0.87	0.68		0.24	0.24 1.77 3.39	0.27	0.15 0.24 2.01	0.24	0.64	0.27 0.27 1.83		0.66 2.13 3.39	0.30	0.24 0.15 2.01	0.15	0.24	0.51 0.30 1.83	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	1.62	1.50		0.18	0.45 0.68 3.12	0.21	0.24 0.81 2.34	0.24	0.21	0.36 0.39 0.75		1.50 3.12 3.12	0.81	0.90 1.59 2.34	0.15	0.21	0.36 1.05 0.75	
B-3	"	3	5-10 10-20 30	0.75	0.83		0.33	0.66 2.85 3.24	0.60	0.30 1.53 2.01	0.36	0.21	0.51 0.27 0.39		2.31 3.39 3.24	0.81	0.99 1.89 2.01	0.24	0.18	0.63 2.43 2.01	
B-4	"	4	5-10 10-20 30	1.29	1.32		1.62	0.75 0.69 3.12	0.81	0.36 1.89 2.34	0.15	0.48	1.02 0.57 1.53		0.60 2.46 3.12	0.30	1.50 2.10 2.34	0.48	0.51	0.45 0.24 1.53	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	2.43	0.63		0.54	1.11 3.00 2.85	0.60	1.80 2.01 2.22	0.57	0.54	0.78 2.10 2.61		2.46 3.06 2.85	0.24	0.75 1.89 2.22	0.27	0.60	0.84 0.66 2.61	
C-3	"	3	5-10 10-20 30	2.34	2.18		2.73	0.90 3.24 3.24	0.51	0.99 2.22 2.34	0.60	0.96	0.51 0.78 1.98		0.96 3.24 3.24	0.60	1.80 2.16 2.34	0.87	0.54	2.10 0.84 1.98	
C-4	"	4	5-10 10-20 30	3.06	2.04		1.68	2.01 3.12 3.00	1.62	2.49 2.55 2.55	1.41	0.93	0.48 0.51 1.47		1.74 3.00 3.00	0.33	2.16 1.59 2.55	0.87	0.63	1.71 2.43 1.47	
.. .	.. .																				

Table 48. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + tertiary sand + NPK	1	5-10 10-20 30	1.86	1.62		1.05	1.53 2.73 3.12	0.90	0.51 1.50 1.95	1.20	0.78	0.84 0.78 2.10		0.78 2.58 3.12	0.60	2.07 2.67 1.95	1.83	1.77	1.20 2.25 2.10	
D-2	"	2	5-10 10-20 30	2.73	1.22		0.66	0.87 2.73 3.00	2.13	1.68 2.22 2.22	1.98	0.90	3.00 2.73 3.36		1.38 2.73 3.00	0.78	1.59 1.89 2.22	0.51	0.69	3.00 2.25 3.36	
D-3	"	3	5-10 10-20 30	2.91	1.43		1.14	2.40 3.66 3.66	1.83	1.74 2.01 2.10	0.93	0.84	1.17 1.65 3.00		1.59 2.31 3.66	0.33	1.56 2.25 2.10	0.75	0.81	1.83 1.17 3.00	
E-1	Ash + low moor peat + NPK	1	5-10 10-20 30	3.21	2.37		3.42	2.88 3.57 4.14	2.46	2.40 3.21 3.27	2.10	2.25	1.71 2.25 2.61		2.82 3.36 4.14	2.58	2.16 3.15 3.27	2.10	1.65	1.83 2.82 2.61	
E-2	"	2	5-10 10-20	3.21	2.79		3.21	2.64 3.06 3.27	3.39	2.40 2.91 2.82	1.04	2.13	1.83 2.43 2.82		2.04 3.63 3.27	2.94	2.91 3.21 2.82	2.25	3.00	2.82 2.43 2.82	
E-3	"	3	5-10 10-20 30	3.21	2.46		3.66	2.82 3.57 3.63	2.58	3.48 2.91 2.73	2.16	2.25	2.43 2.61 3.36		2.82 3.42 3.63	3.09	2.22 2.40 2.73	2.25	2.25	1.32 1.98 3.36	
F-1	Ash + high moor peat + NPK	1	5-10 10-20 30	2.58	2.79		3.57	3.00 3.51 3.36	2.67	2.67 2.73 3.00	2.16	2.46	2.10 2.61 3.18		2.67 2.88 3.36	2.73	2.49 2.58 3.00	2.43	2.64	1.98 2.43 3.18	
F-2	"	2	5-10 10-20 30	3.21	2.64		3.21	3.63 3.57 3.63	3.00	2.40 2.91 2.49	2.10	2.81	1.98 2.61 3.18		2.88 3.27 3.63	2.58	2.40 3.00 2.49	2.58	2.07	1.98 2.43 3.18	
F-3	"	3	5- 10 10-20 30	3.54	3.24		3.36	3.00 3.42 3.72	2.73	2.67 3.36 3.00	1.98	2.07	2.25 2.43 3.00		2.67 3.42 3.72	3.00	2.91 3.00 3.06	2.10	2.01	2.10 3.00 3.00	
G-1	Ash + farm manure + NPK	1	5-10 10-20 30	3.06	2.79		3.21	3.00 3.15 3.42	3.00	3.00 3.21 3.48	2.10	2.01	2.82 3.00 2.43		2.64 3.42 3.42	2.73	2.82 3.63 3.48	2.16	2.01	2.82 3.18 2.43	
G-2	"	2	5-10 10-20 30	3.78	3.24		3.21	2.73 3.72 3.57	2.88	2.43 2.82 3.06	1.89	2.82	2.10 3.18 1.83		2.49 3.57 3.57	3.30	2.22 2.67 3.06	2.25	2.64	2.43 2.43 3.18	
G-3	"	3	5-10 10-20 30	3.96	3.18		3.36	3.27 3.72 3.27	2.73	2.67 3.00 2.82	1.98	2.07	1.98 2.61 2.61		3.27 3.72 3.27	2.88	2.73 3.06 2.82	1.23	2.37	1.98 2.43 2.61	
H(K)-1	Ash + N2PK + green manure (corn)	1	5-10 10-20 30	3.21	3.72		4.20	3.57 3.87 4.14	2.88	3.06 3.06 3.00	2.76	2.25	2.82 3.36 3.36		3.00 3.57 4.14	3.45	2.58 3.48 3.00	2.25	2.13	2.10 2.43 3.36	
H(K)-2	"	2	5-10 10-20 30	3.21	3.09		3.90	2.49 3.42 3.27	3.30	2.67 3.18 3.36	2.25	2.55	1.71 2.25 2.82		3.27 3.72 3.27	3.39	2.67 3.06 3.36	2.43	2.55	1.98 1.83 2.82	
H(K)-3	"	3	5-10 10-20 30	3.69	3.87		4.32	4.14 4.14 3.72	2.88	2.10 2.49 2.58	1.89	2.73	2.61 2.61 3.36		3.15 3.42 3.72	3.30	3.15 2.73 2.58	2.49	2.55	1.98 2.61 3.36	
..	.. .																				

Table 48. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5–10 10–20 30	3.21	3.60		3.72	3.57 4.14 4.44	3.09	2.40 2.82 2.01	1.98	3.48	2.61 2.61 2.43		3.27 3.57 4.44	3.21	2.16 2.67 2.01	2.25	2.13	2.13 2.43 2.43	
I-2	"	2	5–10 10–20 30	2.73	3.00		2.94	3.15 3.72 3.72	3.00	2.67 2.58 2.58	2.25	3.42	2.43 3.36 4.05		3.27 3.87 3.72	3.15	2.25 2.58 2.58	2.25	3.15	2.43 2.61 4.05	
I-3	"	3	5–10 10–20 30	3.30	3.24		3.56	3.42 3.99 3.72	3.30	2.67 3.69 3.00	2.16	2.46	2.35 2.61 2.61		3.15 3.72 3.72	3.21	2.67 3.36 3.00	2.16	2.73	2.82 3.00 2.61	
O-1	Ash without fertilization till 1976 (control)	1	5–10 10–20 30	3.00	3.00		2.82	2.37 2.88 3.15	2.46	2.10 2.73 2.40	1.35	1.77	1.98 2.25 3.00		2.43 3.27 3.15	2.58	2.10 2.49 2.40	2.07	1.83	1.83 0.78 3.00	
O-2	"	2	5–10 10–20 30	2.67	3.30		3.00	3.15 3.72 3.72	3.06	2.01 1.89 2.10	2.25	2.09	2.10 2.82 3.00		3.06 3.06 3.72	2.64	2.34 2.49 2.10	1.77	2.46	1.98 3.00 3.00	
O-3	"	3	5–10 10–20 30	3.63	3.36		3.15	3.72 3.99 4.29	2.67	2.22 2.82 2.67	2.25	2.13	1.32 1.98 2.61		3.87 3.72 4.29	2.88	2.82 2.67 2.67	2.31	3.15	1.71 2.43 2.61	

Note: 1) S = Spring
a = Fall
2) Figures in col. 3
denote cultivation of:
1 - sainfoin with crown vetch
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Content of humus in produced ash soils [C org. in percents]

Helemba

Table 49

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of C org. in soils [percent]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	5.19	2.15	3.20	5.61	2.49 4.55 4.77	2.62	4.62 5.97 5.28	4.72	7.57	6.36 7.86 8.21		2.82 5.16 6.93	3.62	5.79 6.42 5.28	5.07	9.03 8.01 8.21	7.38	
A-3	"	3	5-10 10-20 30	5.59	2.60	4.65	6.82	4.98 6.00 4.68	3.15	6.60 6.15 4.92	4.00	8.68	8.05 7.93 8.15		3.54 2.55 7.50	4.85	4.74 4.62 4.92	4.42	8.98	7.85 7.96 8.15	
A-4	"	4	5-10 10-20 30	5.16	2.75	5.08	5.33	4.38 4.74 4.56	4.40	4.68 4.56 4.62	4.30	12.31	8.25 7.75 8.10		5.19 3.93 5.49	5.08	6.15 5.55 4.62	5.04	10.10	7.17 5.38 8.10	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	2.61	3.15	6.35	7.16	4.44 5.40 4.80	3.91	4.86 5.46 5.85	3.47	7.32	5.58 6.39 4.39		5.58 4.86 5.82	8.19	3.51 4.05 5.85	4.36	9.44	4.68 4.65 4.35	
B-3	"	3	5-10 10-20 30	8.00	3.60	5.91	7.16	3.99 4.98 4.95	5.73	5.58 5.28 2.88	5.91	10.20	5.94 5.19 4.74		4.32 5.34 3.75	9.18	5.19 3.90 2.88	5.70	10.80	5.94 4.59 4.74	
B-4	"	4	5-10 10-20 30	7.96	2.42	4.65	6.66	5.07 4.41 3.97	5.26	5.34 3.12 4.92	8.76	10.15	5.43 4.68 4.98		5.58 4.20 3.36	5.03	4.62 4.41 4.92	6.08	10.15	7.86 5.70 4.98	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	5.64	3.09	4.07	3.78	4.56 4.02 4.59	3.51	4.47 2.70 5.34	5.19	10.95	5.88 2.13 4.20		3.42 4.08 4.35	4.59	4.86 2.76 5.34	6.35	3.36	5.16 5.13 4.20	
C-3	"	3	5-10 10-20 30	5.46	2.33	3.81	4.40	2.61 1.71 1.89	3.45	2.19 1.86 1.65	3.71	4.72	3.12 1.74 2.19		3.69 3.12 1.89	3.56	5.43 2.10 1.65	5.52	8.94	3.06 2.64 2.19	
C-4	"	4	5-10 10-20 30	5.17	1.36	2.95	4.91	3.09 1.80 1.29	1.57	2.01 1.26 1.08	2.91	3.31	2.64 2.01 1.98		2.76 1.89 1.35	2.92	2.52 1.92 1.08	3.95	5.22	2.79 2.73 1.98	
..	. . .																				

Table 49. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5-10	2.97	2.15	3.31	2.37	2.07	1.40	2.10	2.91	2.19	2.04		3.75	1.69	2.88	1.78	2.39	3.12	
			10-20					1.53		1.29			1.38		3.15		1.65			2.52	
			30					1.95		0.72			1.74		2.40		0.72			1.74	
D-2	"	2	5-10	3.15	2.09	3.81	2.31	1.38	2.86	0.99	2.37	1.54	1.47		4.08	1.72	2.37	3.02	3.34	3.72	
			10-20					1.38		1.14			1.44		1.47		1.32			3.45	
			30					2.16		1.59			1.35		1.86		1.59			1.35	
D-3	"	3	5-10	2.64	3.34	3.89	2.45	1.29	3.15	1.02	2.52	1.74	1.62		1.44	1.75	1.26	1.90	1.84	2.28	
			10-20					1.71		1.98			1.44		0.93		0.66			1.86	
			30					3.18		3.54			2.25		4.23		3.54			2.25	
E-1	Ash + low moor peat + NPK	1	5-10	4.74	6.22	5.73	4.50	5.64	5.67	6.90	4.78	8.04	5.04		6.69	5.32	6.72	5.34	11.95	4.89	
			10-20					7.26		7.26			4.35		5.82		6.60			5.34	
			30					5.28		6.45			4.77		8.10		6.45			4.77	
E-2	"	2	5-10	6.38	4.65	4.43	4.20	5.70	5.89	6.24	5.34	9.34	4.62		6.57	5.49	4.86	5.01	9.79	4.59	
			10-20					6.39		4.92			4.80		4.83		6.33			4.56	
			30					6.57		8.46			4.32		7.53		8.46			4.32	
E-3	"	3	5-10	6.37	5.02	4.71	3.58	5.01	4.56	5.52	3.71	4.89	4.98		5.28	4.56	5.10	5.82	9.14	4.80	
			10-20					5.85		3.93			5.28		6.87		5.22			5.22	
			30					4.56		5.16			4.62		8.40		5.16			4.62	
F-1	Ash + high moor peat + NPK	1	5-10	5.06	4.55	5.38	3.15	4.56	4.32	4.62	4.12	4.73	4.35		5.16	6.08	4.80	4.42	4.76	4.68	
			10-20					5.25		4.77			5.04		5.38		6.24			3.72	
			30					3.42		4.38			3.45		5.58		4.38			3.45	
F-2	"	2	5-10	4.90	4.08	4.27	3.24	4.26	2.86	4.35	3.50	4.53	4.11		4.74	3.62	5.52	3.32	4.70	4.65	
			10-20					6.66		4.44			4.05		4.14		4.89			4.74	
			30					4.50		4.92			5.16		4.47		4.92			5.16	
F-3	"	3	5-10	3.60	4.70	3.07	3.26	2.88	3.48	3.54	3.29	4.16	5.25		4.32	3.10	3.00	2.97	5.67	4.50	
			10-20					3.09		4.89			4.44		4.53		4.41			4.20	
			30					5.25		4.32			4.05		4.74		4.35			4.05	
G-1	Ash + farm manure + NPK	1	5-10	2.46	2.87	3.14	1.91	3.90	2.80	3.36	4.48	3.76	5.28		3.72	3.60	4.47	3.80	3.61	4.32	
			10-20					4.62		3.42			5.46		4.62		3.06			4.14	
			30					5.04		5.13			4.08		4.32		5.13			4.08	
G-2	"	2	5-10	2.73	3.45	2.92	2.69	2.85	2.57	3.57	2.94	8.54	4.44		3.60	3.15	2.82	2.85	4.27	5.04	
			10-20					1.80		4.20			5.40		2.37		2.52			4.47	
			30					3.60		3.60			5.88		4.68		3.60			5.88	
G-3	"	3	5-10	3.15	4.60	3.25	2.77	4.05	3.86	3.87	2.76	3.33	4.92		4.89	3.30	3.84	3.32	4.05	4.32	
			10-20					5.22		3.87			5.40		4.14		3.72			5.13	
			30					4.50		4.92			5.16		4.47		4.92			5.16	
H-1	Ash +N2PK	1	5-10	4.37	3.19	4.31	2.79	4.38	3.56	3.78	3.97	8.24	5.28		4.80	3.04	5.43	4.33	3.25	5.58	
			10-20					5.34		3.96			5.40		6.06		5.88			5.31	
			30					2.76		4.41			5.16		6.99		4.87			5.16	
H-2	"	2	5-10	4.05	4.44	4.33	3.16	4.41	4.32	3.84	4.39	4.10	4.05		4.29	4.30	4.44	4.78	7.18	4.05	
			10-20					5.40		4.62			4.53		5.37		4.02			3.66	
			30					3.00		4.08			4.23		3.96		4.08			4.23	
H-3	"	3	5-10	3.54	3.81	4.36	2.99	5.91	2.92	4.35	4.75	4.13	5.28		7.83	3.97	5.37	3.97	3.97	5.91	
			10-20					5.25		4.83			4.50		6.66		4.71			4.44	
			30					5.13		5.04			5.13		8.04		5.04			5.13	

Table 49. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10	2.40	1.62	1.80	2.24	3.51	2.69	2.22	3.32	2.28	3.24		1.89	1.34	1.11	1.93	1.15	1.68	
			10-20					3.18		2.04			3.30		1.74		1.80			1.74	
			30					5.43		4.26			3.93		2.25		2.58			3.93	
I-2	"	2	5-10	2.52	2.14	1.77	2.47	3.66	3.42	2.58	2.85	5.72	4.14		4.26	1.34	3.12	3.11	2.10	3.00	
			10-20					3.30		1.80			2.94		3.45		1.68			3.33	
			30					4.74		2.94			2.31		2.37		2.94			2.31	
I-3	"	3	5-10	2.61	3.66	2.91	2.43	4.50	4.27	3.90	4.15	3.46	3.51		7.56	2.36	6.42	3.74	8.99	4.92	
			10-20					4.20		3.54			4.17		4.98		6.48			4.35	
			30					5.72		3.54			5.19		6.03		3.54			5.19	
0-1	Ash without fertilization till 1976 (control)	1	5-10	4.05	5.49	3.87	4.09	5.40	4.03	7.14	6.17	4.87	5.22		7.59	3.27	4.17	4.75	3.60	5.88	
			10-20					7.05		8.64			6.06		7.02		4.17			6.39	
			30					6.25		7.14			6.66		7.14		7.14			6.66	
0-2	"	2	5-10	4.57	4.55	3.25	3.51	6.09	3.86	4.92	5.13	10.95	5.82		4.86	4.83	4.95	4.12	7.48	5.01	
			10-20					4.35		4.44			4.89		6.03		4.98			5.25	
			30					7.32		5.31			3.93		8.43		5.31			3.93	
0-3	"	3	5-10	4.80	4.18	3.13	3.13	7.71	4.32	3.57	4.36	7.28	4.17		6.12	4.27	7.02	6.44	10.15	6.06	
			10-20					5.82		4.92			5.04		6.39		5.67			4.83	
			30					4.92		4.65			6.42		5.85		4.65			6.42	

Note: 1) S = Spring
a = Fall

2) Figures in col. 3
denote cultivation of:
1 - lucerne with
sweetclover
2 - mixture of grasses
and legumes
3 - lucerne with
orchard grass
4 - sweetclover

Content of humus in produced ash soils [C org. percent]

Konin

Table 50

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of C org. in soils [percent]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5–10 10_20 30	0.81	1.09	0.93	0.93	0.99 0.66 0.57	0.92	0.83 0.71 0.95	1.09	0.95	2.43 2.25 2.43		0.96 0.75 0157	0.78	0.89 0.83 0.95	1.08	0.74	2.01 2.34 2.43	
A-3	"	3	5–10 10–20 30	0.81	0.84	0.88	0.84	0.93 0.96 0.96	0.93	0.98 0.86 0.80	0.92	1.04	2.13 2.16 2.34		1.05 1.02 0.96	0.80	0.89 0.83 0.80	1.05	0.84	1.95 2.88 2.34	
A-4	"	4	5–10 10–20 30	0.87	0.99	0.88	0.88	1.17 1.02 1.20	0.90	0.94 0.86 0.92	1.12	0.89	2.56 2.46 2.22		1.14 1.08 1.20	0.80	0.86 0.85 0.92	1.05	0.92	2.70 2.76 2.22	
B-2	Ash + 10 cm of fertile soil + NPK	2	5–10 10–20 30	0.81	0.84	0.84	0.97	0.90 0.96 1.02	0.78	0.95 0.89 0.98	0.92	0.98	2.88 2.64 2.34		0.96 0.66 1.02	0.83	1.05 0.89 0.98	0.92	0.84	2.73 1.18 2.34	
B-3	"	3	5–10 10–20 30	0.87	0.84	0.87	0.96	0.84 0.93 0.72	0.92	0.95 1.01 1.20	0.93	0.84	2.37 2.70 2.91		1.11 0.63 0.72	0.83	0.98 0.99 1.20	0.98	0.72	2.91 2.64 2.91	
B-4	"	4	5–10 10–20 30	0.78	09.0	0.98	0.87	0.99 0.66 1.05	0.89	0.91 0.74 0.94	0.96	1.07	2.37 2.52 2.40		0.93 0.96 1.05	0.81	0.95 1.52 0.94	1.12	0.80	2.52 2.19 2.40	
C-2	Ash + 5 cm of fertile soil ÷ NPK	2	5–10 10_20 30	0.74	0.90	0.93	0.84	0.99 0.75 0.84	0.87	0.86 0.70 0.50	0.81	0.74	2.58 2.25 2.19		1.05 0.96 0.84	0.86	0.86 1.04 0.50	0.98	0.99	2.25 2.04 2.19	
C-3	"	3	5–10 10–20 30	0.76	0.93	0.98	0.76	C.96 0.39 0.39	0.89	0.67 0.74 0.76	0.84	0.30	2.28 2.16 2.34		0.78 1.02 0.39	0.99	0.80 0.97 0.76	0.80	0.84	2.43 2.25 2.34	
C-4	"	4	5–10 10–20 30	0.71	0.87	0.78	0.54	0.60 1.05 0.72	0.92	0.62 0.65 0.73	0.90	0.78	2.31 2.64 2.79		1.03 0.79 0.72	0.84	0.74 0.92 0.73	1.09	0.77	2.82 2.58 2.79	
..	. .. .																				

Table 50. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + tertiary sand + NPK	1	5–10	0.90	1.30	1.51	1.31	0.84	0.90	0.76	0.56	0.77	1.17		0.85	1.60	1.43	0.92	1.06	1.44	
			10–20					0.78		0.77			1.23		1.05		1.10			2.70	
			30					0.75		0.68			1.15		0.75		0.68			1.15	
D-2	"	2	5–10	1.04	1.30	1.13	0.71	1.18	1.36	1.04	1.17	0.99	2.58		1.38	1.33	0.94	1.09	1.15	1.11	
			10–20					1.08		1.05			1.33		1.24		1.73			1.21	
			30					0.96		0.95			1.39		0.96		0.92			1.39	
D-3	"	3	5–10	1.09	1.30	1.25	0.89	1.20	1.27	1.32	1.35	1.15	1.14		1.03	0.92	1.47	1.45	1.30	1.08	
			10–20					1.15		1.05			1.14		0.94		1.28			1.02	
			30					1.33		0.95			1.20		1.33		0.95			1.20	
E-1	Ash + low moor peat + NPK	1	5–10	1.86	3.09	2.18	2.17	2.41	2.01	2.31	2.50	1.99	1.15		3.12	2.21	2.92	2.94	1.84	1.18	
			10–20					2.39		1.95			1.12		3.01		2.40			0.99	
			30					2.38		1.39			1.14		2.38		1.39			1.14	
E-2	"	2	5–10	1.57	3.18	2.47	2.16	2.56	1.88	2.22	2.67	2.22	1.11		2.60	2.33	1.74	2.33	2.43	1.24	
			10–20					2.51		2.52			1.38		2.80		2.32			1.39	
			30					1.95		2.17			1.35		1.95		2.17			1.35	
E-3	"	3	5–10	1.51	2.96	2.26	2.32	2.17	2.19	2.38	2.43	2.33	1.20		2.45	2.04	2.17	2.86	1.99	1.05	
			10–20					3.01		2.08			1.06		2.29		1.88			1.18	
			30					2.53		2.05			1.06		2.53		2.06			1.06	
F-1	Ash + high moor peat + NPK	1	5–10	1.88	3.48	2.52	2.83	2.71	2.61	2.71	2.40	2.45	1.20		3.07	2.28	2.65	3.17	2.62	1.48	
			10–20					3.28		2.50			1.39		1.76		3.23			1.44	
			30					3.31		2.56			1.29		3.31		2.56			1.29	
F-2	"	2	5–10	1.56	2.81	2.40	3.10	2.60	2.33	2.70	2.55	2.80	1.08		2.30	1.47	2.53	2.39	2.45	1.06	
			10–20					2.00		2.62			1.20		2.62		2.65			1.11	
			30					2.96		2.25			1.18		2.96		2.25			1.18	
F-3	"	3	5–10	2.03	3.33	2.56	1.89	2.07	2.47	2.73	2.73	2.46	1.11		2.30	2.43	2.59	2.36	2.84	1.03	
			10–20					2.14		2.58			1.20		2.30		2.29			1.08	
			30					2.05		2.32			1.14		2.05		2.32			1.14	
G-1	Ash + farm manure + NPK	1	5–10	1.77	2.75	2.30	2.17	2.59	1.37	2.50	1.98	2.30	1.44		2.39	2.55	2.19	2.46	1.84	1.03	
			10–20					2.35		2.07			1.33		2.28		2.23			1.26	
			30					2.44		2.31			1.11		2.44		2.31			1.11	
G-2	"	2	5–10	1.90	2.57	2.03	1.16	2.36	1.57	2.32	2.07	2.30	1.12		2.14	4.85	2.23	1.96	1.54	1.17	
			10–20					2.38		2.17			1.08		2.11		2.02			1.45	
			30					2.41		2.59			1.14		2.41		2.59			1.14	
G-3	"	3	5–10	1.79	2.33	1.97	2.50	2.08	1.97	1.76	2.04	1.93	1.33		1.91	1.76	1.13	1.27	1.80	1.15	
			10–20					2.15		2.22			1.32		2.80		0.98			1.05	
			30					2.33		2.20			1.68		2.33		2.20			1.68	
H-1	Ash + N2PK + green manure (corn)	1	5–10	1.56	2.24	2.63	1.70	1.50	1.81	1.98	2.25	2.09	1.41		2.65	2.36	2.41	1.84	2.22	1.11	
			10–20					1.89		2.11			1.27		2.23		1.98			1.47	
			30					1.70		3.42			1.23		1.70		3.42			1.23	
H-2	"	2	5–10	2.00	2.42	2.06	2.26	2.09	1.41	1.88	1.96	2.01	1.48		2.08	2.95	1.99	1.66	1.84	1.50	
			10–20					1.79		1.98			1.44		1.82		2.06			1.50	
			30					2.11		2.04			1.62		2.11		2.04			1.62	
H-3	"	3	5–10	2.01	2.45	2.44	2.38	2.63	2.07	2.17	1.90	1.95	1.45		1.97	1.87	2.70	2.12	1.96	1.44	
			10–20					2.42		1.65			1.62		1.95		2.29			1.41	
			30					2.86		1.94			1.50		2.86		1.94			1.50	

Table 50. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10 10-20 30	1.95	2.69	2.48	2.50	2.35 2.32 2.74	2.12	2.23 2.71 3.21	2.13	2.40	1.44 1.51 1.59		2.30 2.35 2.74	2.73	2.82 2.11 3.21	2.16	2.34	1.46 1.33 1.59	
I-2	Ash + NPK	2	5-10 10-20 30	1.90	2.15	2.13	2.95	2.31 2.73 2.17	2.07	1.67 1.77 1.35	2.28	1.96	1.42 1.38 1.41		2.28 2.00 2.17	1.98	2.04 2.17 1.35	2.03	1.95	0.99 1.41 1.41	
I-3	Ash + NPK	3	5-10 10-20 30	1.60	3.03	1.62	2.59	2.38 2.07 2.37	2.15	2.29 1.97 2.47	2.33	2.40	1.09 1.11 0.96		2.19 2.14 2.37	2.13	2.53 2.94 2.47	2.24	2.15	1.24 1.20 0.96	
0-1	Ash without fertilization till 1976 (control)	1	5-10 10-20 30	1.11	1.15	1.49	1.05	0.94 0.81 0.90	1.30	0.92 1.07 1.19	1.48	1.60	0.99 1.08 1.32		1.17 1.11 0.90	1.29	1.08 1.28 1.19	1.14	1.15	1.03 1.32 1.32	
0-2	"	2	5-10 10-20 30	1.46	1.36	1.36	1.04	1.09 2.07 0.78	1.54	1.55 0.35 7.62	1.32	1.24	1.21 1.20 1.11		3.99 2.10 6.78	1.12	1.73 1.02 7.62	1.33	1.16	1.02 1.06 1.11	
0-3	"	3	5-10 10-20 30	1.81	2.27	1.77	2.50	2.01 1.69 1.89	2.00	1.76 2.23 2.02	1.75	1.69	1.09 1.11 0.93		1.48 1.66 1.89	2.00	1.82 2.22 2.02	1.96	1.98	1.05 1.03 0.93	

Note: 1) S = Spring
a = Fall
2) Figures in col. 3
denote cultivation of:
1 - sainfoin with
crown vetch
2 - mixture of grasses
with legumes
3 - lucerne with
orchard grass
4 - sweetclover

Content of P_2O_5 in produced ash soils

Halemba

Table 51

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of P_2O_5 acc. to Egner [mg/100 g of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	11.8	2.3	5.0	2.0	4.6 8.6 24.0	2.9	3.2 4.6 25.0	4.6	12.5	6.0 4.6 16.5		1.8 1.7 100.0	1.3	7.8	1.3 91.5 25.0	1.3	2.5 24.0	
A-3	"	3	5-10 10-20 30	4.6	2.5	2.3	2.7	4.2 6.4 48.5	1.4	6.4 4.6 77.5	5.6	8.0	3.6 10.9 59.0		1.8 1.3 100.0	1.3	3.4 2.3 77.5	2.7	1.3	5.0 4.4	
A-4	"	4	5-10 10-20 30	22.0	9.0	13.6	15.0	3.6 6.0 22.9	3.8	4.9 63.5 73.0	5.6	6.6	14.5 5.8 40.0		2.3 2.2 72.5	16.5	25.0 75.0 73.0	2.3	3.6	2.0 1.4	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	7.8	3.0	4.0	4.6	3.6 4.0 54.5	5.8	19.0 25.0 56.5	3.0	15.5	4.2 22.9 35.0		15.0 24.0 45.0	2.3	13.4 41.0 56.5	3.0	4.0	10.3 80.0	
B-3	"	3	5-10 10-20 30	16.5	2.5	1.7	5.0	24.0 8.3 51.5	5.0	14.6 14.6 25.0	6.0	14.0	8.6 25.0 43.0		4.2 12.5 34.0	6.6	5.8 21.9 25.0	24.0	4.8	4.6 17.7	
B-4	"	4	5-10 10-20 30	12.5	8.0	5.4	3.4	10.6 19.1 57.5	13.6	7.8 15.0 41.0	6.2	9.7	10.0 14.5 25.0		4.8 25.0 25.0	16.5	4.0 43.0 41.0	21.0	4.2	3.8 9.4	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	14.0	82.5	15.0	48.5	20.0 56.0 51.5	18.3	16.0 24.1 56.5	39.0	15.5	25.0 40.0 35.0		48.5 10.0 34.0	19.1	35.0 21.9 56.5	22.0	34.0	11.2 17.7	
C-3	"	3	5-10 10-20 30	25.0	36.5	17.0	16.5	36.5 15.5 37.5	13.2	32.0 12.7 20.0	31.0	40.0	25.0 22.9 18.3		48.5 30.0 22.0	18.3	21.9 11.0 20.0	16.0	24.0	41.5 20.0	
C-4	"	4	5-10 10-20 30	35.0	56.0	21.0	48.5	37.5 13.6 17.7	7.0	20.0 10.0 21.9	22.9	24.0	33.0 22.9 12.5		30.0 12.9 17.7	19.1	25.0 7.8 22.0	24.0	18.3	39.0 16.5	

Table 51. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5–10 10–20 30	75.0	59.0	25.0	75.0	32.0 25.0 12.5	14.0	22.9 27.0 22.9	54.5	37.5	44.0 21.0 24.0		77.5 57.5 21.0	21.0	67.0 39.9 22.9	35.0	47.0	59.0 48.0	
D-2	"	2	5–10 10–20 30	64.0	56.0	59.0	56.0	12.5 15.5 22.0	25.0	6.4 24.1 25.0	17.7	14.0	14.5 9.7 12.2		48.5 16.5 33.0	16.5	34.0 21.9 25.0	57.5	56.0	54.5 50.0	
D-3	"	3	5–10 10–20 30	59.0	75.0	62.5	56.0	21.0 22.0 33.0	18.3	11.0 13.8 39.0	24.0	31.0	21.0 12.2 20.0		25.0 12.2 40.0	18.3	10.3 40.0 39.0	45.0	30.0	35.0 32.0	
E-1	Ash + low moor peat + NPK	1	5–10 10–20 30	88.5	120.0	88.5	61.0	80.0 80.0 61.0	22.9	80.0 58.5 69.0	82.5	82.5	114.5 95.5 68.0		88.5 77.5 80.0	105.0	104.5 88.5 69.0	95.5	100.0	110.0 120.0	
E-2	"	2	5–10 10–20 30	56.0	68.0	82.5	25.0	68.0 62.5 64.5	21.0	77.5 85.0 91.5	72.5	66.0	75.0 56.0 54.5		85.0 59.0 53.0	25.0	69.0 75.0 91.5	80.0	75.0	95.5 114.5	
E-3	"	3	5–10 10–20 30	56.0	75.0	24.0	22.9	61.0 61.0 48.5	20.0	44.0 56.5 42.0	68.0	53.0	95.5 82.5 59.0		43.0 56.0 62.5	22.9	56.5 47.0 42.0	66.0	75.0	68.0 59.0	
F-1	Ash + high moor peat + NPK	1	5–10 10–20 30	54.5	50.0	66.0	54.5	56.0 57.5 33.0	24.0	58.5 58.5 44.0	50.0	62.5	62.5 30.0 53.0		50.0 56.0 54.5	14.0	64.0 71.0 44.0	66.0	62.5	68.0 68.0	
F-2	"	2	5–10 10–20 30	53.0	45.0	22.0	50.0	39.0 45.0 33.0	20.0	43.0 40.0 36.0	48.5	39.0	53.0 43.0 32.0		43.0 45.0 43.0	18.3	56.5 41.0 36.0	47.0	50.0	61.0 51.5	
F-3	"	3	5–10 10–20 30	37.5	56.0	25.0	48.5	24.0 21.0 44.0	17.7	50.0 35.0 43.0	57.5	54.5	43.0 32.0 27.0		36.5 37.5 41.5	21.0	30.0 35.0 43.0	43.0	32.0	39.0 39.0	
G-1	Ash + farm manure + NPK	1	5–10 10–20 30	36.5	33.0	25.0	37.5	48.5 35.0 39.0	16.5	44.0 29.0 44.0	56.0	44.0	53.0 32.0 24.0		35.0 35.0 35.0	24.0	44.0 29.0 44.0	66.0	50.0	59.0 39.0	
G-2	"	2	5–10 10–20 30	19.1	37.5	19.1	27.0	41.5 15.0 35.0	17.7	55.0 40.0 31.0	22.0	59.0	48.5 26.0 12.9		57.5 11.5 35.0	59.0	45.5 19.0 31.0	33.0	44.0	48.5 37.5	
G-3	"	3	5–10 10–20 30	41.5	60.0	25.0	27.0	61.0 24.0 37.5	20.0	40.0 25.0 37.5	45.0	37.5	61.0 26.0 30.0		44.0 28.0 36.5	18.3	42.0 28.0 37.0	61.0	70.0	31.0 17.0	
H-1	Ash + N2PK	1	5–10 10–20 30	75.0	59.0	100.0	53.0	51.5 50.0 59.0	24.0	53.0 51.5 51.5	56.0	92.5	75.0 50.0 39.0		75.0 56.0 25.0	22.9	80.0 63.5 51.5	61.0	47.0	72.5 77.5	
H-2	"	2	5–10 10–20 30	57.5	57.5	68.0	48.5	51.5 47.0 22.9	22.9	44.0 45.5 29.0	54.5	62.5	56.0 43.0 41.5		45.0 48.5 22.9	22.0	65.0 61.5 29.0	82.5	88.5	56.0 50.0	
H-3	"	3	5–10 10–20 30	72.5	75.0	66.0	68.0	59.0 57.5 35.0	20.0	48.5 44.0 43.0	68.0	45.0	61.0 54.5 51.5		59.0 61.0 43.0	25.0	71.0 56.5 43.0	85.0	75.0	54.5 56.0	
..	.. .																				

Table 51. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10 10-20 30	43.0	26.0	15.5	53.0	36.5 25.0 50.0	22.9	28.0 25.0 32.0	54.5	25.0	41.5 16.5 36.5		20.0 22.0 30.0	15.5	12.0 24.1 32.0	22.9	10.6	22.0 14.5	
I-2	"	2	5-10 10-20 30	46.0	28.0	22.9	50.0	43.0 30.0 37.5	20.0	16.5 18.3 25.0	36.5	48.5	19.1 40.0 22.0		21.0 21.0 53.0	22.0	36.0 20.0 25.0	36.5	25.0	26.0 35.0	
I-3	"	3	5-10 10-20 30	31.0	33.0	17.0	33.0	41.5 47.0 82.5	22.9	42.0 32.0 42.0	31.0	31.0	59.5 35.0 36.0		61.0 50.0 48.5	20.0	67.0 51.5 42.0	85.0	61.0	72.5 75.0	
0-1	Ash without fertilization till 1976 (control)	1	5-10 10-20 30	43.0	54.5	21.0	37.5	77.5 68.0 61.0	22.9	56.5 73.0 61.5	51.5	59.0	53.0 54.5 51.5		70.0 54.5 47.0	22.9	64.0 48.5 61.5	62.5	64.5	54.5 53.0	
0-2	"	2	5-10 10-20 30	51.5	54.5	53.0	39.0	50.0 53.0 44.0	22.0	63.5 45.5 48.5	63.0	75.0	56.0 41.5 48.5		66.0 62.5 56.0	24.0	88.5 55.0 48.5	64.5	75.0	75.0 59.0	
0-3	"	3	5-10 10-20 30	36.5	48.5	18.3	32.0	53.0 48.5 25.0	20.0	44.0 56.5 48.5	72.5	62.5	48.5 40.0 47.0		70.0 61.0 48.5	25.0	44.0 50.0 48.5	82.5	88.5	77.0 64.5	

Note: 1/ S= Spring
F= Fall

2) Figures in col. 3 denote cultivation of:
1 - lucerne with sweetclover
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Content of P_2O_5 in produced ash soils
Konin

Table 52

No. of plots	Combinations of soils and fertilisers	No. of mix-ture	Sampl-ing depth cm	Measured content of P_2O_5 acc. to Egner [mg/100 g of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	13.2	18.3	15.5	19.1	16.0 9.4 1.3	11.8	7.6 0.6 5.8	21.0	48.5	41.5 15.5 13.2		11.2 8.0 1.3	9.0	7.6 7.2 5.8	14.5	15.3	6.8 4.6	
A-3	"	3	5-10 10-20 30	12.5	20.0	19.1	12.2	16.3 12.2 0.7	16.0	18.1 9.4 2.3	15.5	85.0	25.0 14.0 10.6		11.8 16.0 0.7	15.5	9.7 8.0 2.3	22.9	13.2	20.0 11.2	
A-4	"	4	5-10 10-20 30	17.7	18.3	15.0	11.8	14.0 5.6 0.6	21.0	13.8 11.0 1.8	24.0	22.0	20.0 11.2 4.4		10.9 6.0 0.6	18.3	9.7 7.8 1.8	15.0	15.0	15.0 9.7	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	20.0	21.0	12.5	10.3	10.0 5.2 1.0	16.0	12.0 9.1 0.9	22.0	35.0	19.1 11.2 9.0		10.9 1.2 1.0	16.5	8.4 2.5 0.9	11.8	16.5	10.3 3.4	
B-3	"	3	5-10 10-20 30	11.8	16.0	20.0	18.3	9.4 1.0 0.7	19.1	12.7 2.5 1.4	13.2	10.0	16.5 9.0 7.5		2.5 0.6 0.7	12.5	8.6 2.3 1.4	9.4	11.5	5.4 1.7	
B-4	"	4	5-10 10-20 30	19.1	12.9	13.2	9.7	10.9 11.5 0.1	9.7	20.9 1.4 1.2	15.5	20.0	40.0 8.3 3.8		9.4 2.0 0.1	12.5	8.6 0.6 1.2	14.5	13.2	12.5 7.3	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	17.7	20.0	12.2	12.2	17.0 1.8 2.2	14.5	2.3 1.4 0.6	5.0	35.0	20.0 4.4 2.0		4.2 1.0 2.2	13.2	10.3 1.7 0.6	16.0	16.0	10.6 3.0	
C-3	"	3	5-10 10-20 30	11.2	18.2	12.5	2.5	12.5 0.6 0.6	14.0	8.8 1.6 2.7	15.0	11.5	22.0 4.0 2.5		8.0 1.0 0.6	10.0	2.9 1.0 2.7	7.8	5.4	3.4 14.0	
C-4	"	4	5-10 10-20 30	16.0	11.8	14.5	12.2	12.9 1.4 0.6	5.6	0.5 0.3 1.0	4.6	25.0	22.9 13.2 2.5		3.4 0.5 0.6	12.5	1.6 2.9 1.0	4.2	5.8	7.5 1.7	
..	. .. .																				

Table 32. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + tertiary sand + NPK	1	5–10 10–20 30	12.2	10.6	10.6	12.2	13.6 1.6 0.5	16.0	7.6 8.6 7.2	5.0	17.0	21.0 7.3 2.7		5.8 3.4 0.5	6.4	3.0 0.7 0.7	3.0	6.8	6.4 2.7	
D-2	"	2	5–10 10–20 30	8.0	8.8	20.0	7.5	14.0 1.0 0.3	8.8	4.0 1.6 1.4	7.0	18.3	12.9 3.4 1.6		11.8 2.2 0.3	11.8	2.3 3.8 1.4	7.3	7.0	6.6 2.9	
D-3	"	3	5–10 10–20 30	7.8	10.0	11.5	9.4	3.2 0.5 0.1	7.5	2.9 4.4 2.3	5.2	10.9	10.6 3.6 1.6		11.8 3.2 0.1	8.6	3.2 1.2 2.3	3.8	8.3	8.0 4.0	
E-1	Ash + low moor peat + NPK	1	5–10 10–20 30	5.6	1.2	2.2	1.3	1.3 0.5 0.1	5.4	1.6 0.7 0.1	2.3	4.0	1.8 2.7 1.7		1.6 0.6 0.1	2.5	0.9 0.1 0.1	3.2	2.9	3.0 1.6	
E-2	"	2	5–10 10–20 30	0.7	1.7	3.0	3.8	1.7 0.6 0.6	1.4	1.0 0.3 0.1	1.6	2.9	2.7 1.4 0.6		1.6 0.1 0.6	2.0	0.5 0.1 0.1	1.7	2.5	1.3 3.0	
E-3	"	3	5–10 10–20 30	1.7	1.7	2.0	1.0	1.6 0.1 0.1	3.8	0.9 0.3 0.1	1.7	3.6	3.2 1.7 1.3		0.7 0.5 0.1	2.9	1.0 0.1 0.1	1.8	2.5	2.3 2.3	
F-1	Ash + high moor peat + NPK	2	5–10 10–20 30	1.0	2.2	2.3	3.6	0.7 0.7 0.3	3.2	0.7 0.9 0.5	1.6	3.0	7.3 2.3 1.4		0.9 0.1 0.3	3.6	0.9 0.3 0.5	2.2	1.7	3.9 3.6	
F-2	"	3	5–10 10–20 30	1.2	3.4	3.8	2.5	0.5 0.5 0.3	3.6	0.5 0.1 0.1	1.8	4.4	4.8 1.3 0.6		0.9 0.3 0.3	3.4	0.5 0.3 0.1	1.4	3.0	3.4 1.0	
F-3	"	1	5–10 10–20 30	0.7	2.3	3.0	0.9	0.7 1.0 0.6	2.9	0.9 0.7 0.6	8.3	8.6	8.0 1.0 0.7		1.6 0.7 0.6	6.4	1.8 1.0 0.6	2.0	4.0	3.6 1.7	
G-1	Ash + farm manure + NPK	1	5–10 10–20 30	0.7	3.4	3.8	3.0	2.9 0.7 0.3	2.0	0.9 0.1 0.1	2.9	6.6	6.6 2.7 1.0		1.8 0.3 0.3	2.3	1.4 0.5 0.1	1.6	1.8	6.6 3.6	
G-2	"	2	5–10 10–20 30	0 .7	3.4	3.8	3.0	2.9 0.7 0.3	2.0	0.9 0.1 0.1	2.9	6.6	6.6 2.7 1.0		1.8 0.3 0.3	2.3	1.4 0.5 0.1	1.6	1.8	6.6 3.6	
G-3	"	3	5–10 10–20 30	1.0	0.7	2.7	3.4	0.3 0.3 0.9	2.5	1.7 0.5 0.3	3.4	3.8	7.5 1.7 0.5		0.7 0.3 0.9	6.4	1.2 0.7 0.3	3.8	2.9	6.4 6.8	
H(K)-1	Ash + N2PK + green manure + NPK	1	5–10 10–20 30	0.6	1.2	1.4	2.0	0.9 0.6 0.1	5.0	1.3 0.3 0.1	7.3	4.2	4.0 2.2 1.2		1.4 0.5 0.1	5.4	2.5 1.7 0.1	3.2	3.8	3.4 3.0	
H(K)-2	"	2	5–10 10–20 30	0.7	0.9	1.6	0.6	6.0 1.3 0.9	6.2	1.8 0.7 0.3	3.0	2.3	5.8 4.2 1.2		1.8 0.5 0.9	1.8	0.9 0.5 0.3	2.3	2.7	3.6 2.0	
H(K)-3	"	3	5–10 10–20 30	0.6	2.0	1.6	1.2	1.2 .3 .3	7.3	4.0 1.2 0.6	3.0	1.3	1.6 5.4 0.5		0.7 0.3 0.3	4.0	2.5 1.3 0.6	4.2	3.4	3.2 2.2	

Table 52. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5–10 10–20 30	1.0	1.6	2.5	0.7	1.4 0.5 0.1	3.4	1.3 0.5 0.0	2.7	2.9	5.0 1.6 2.2		0.7 0.3 0.1	5.6	1.4 0.9 0.0	2.3	1.8	5.2 2.2	
I-2	"	2	5–10 10–20 30	1.2	1.0	2.7	0.3	1.3 0.3 0.1	2.0	1.2 0.9 0.5	1.4	1.8	3.2 1.2 0.1		1.3 0.3 0.1	2.7	0.7 0.6 0.5	2.7	1.6	2.3 1.4	
I-3	"	3	5–10 10–20 30	0.3	1.3	2.9	0.9	1.2 0.3 0.5	3.2	0.9 0.3 0.6	2.2	2.0	3.0 2.5 0.9		0.9 0.1 0.5	3.2	1.2 0.5 0.6	1.3	1.8	1.0 0.7	
0-1	Ash without fertilization till 1976 (control)	1	5–10 10–20 30	1.6	1.8	2.0	3.0	1.8 0.6 1.3	3.6	2.2 0.5 0.5	2.9	3.0	5.0 1.6 1.2		0.9 0.6 1.3	4.0	1.7 0.5 0.5	2.9	2.0	2.2 1.3	
0-2	"	2	5–10 10–20 30	1.2	1.2	3.2	1.8	1.2 0.1 0.1	1.6	1.3 0.1 0.1	1.3	1.8	4.2 1.2 0.3		0.9 0.1 0.1	2.3	1.2 0.1 0.1	1.4	1.8	1.6 0.3	
0-3	"	3	5–10 10–20 30	0.5	1.6	2.7	0.7	1.2 0.1 0.1	2.7	1.0 0.6 0.5	2.5	2.2	6.2 2.7 3.6		1.0 0.3 0.1	5.2	1.2 0.5 0.5	2.5	2.3	2.2 1.8	

Note: 1) S - Spring
a - Fall
2) Figures in col. 3 denote cultivation of:
1 - sainfoin with crown vetch
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Content of K_2O in produced ash soils

Halemba

Table 53

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of K_2O [mg/100 g of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	11.5	3.0	4.5	6.0	3.5 3.5 14.0	1.5	2.0 1.5 3.5	4.0	4.5	9.0 5.0 5.5		1.8 1.7 100.0	3.0	2.5 4.0 3.5	3.0	2.5	3.5 3.0 5.5	-
A-3	"	3	5-10 10-20 30	6.5	4.5	3.0	2.5	4.2 6.4 9.5	1.5	2.5 2.5 5.0	3.5	6.5	5.5 7.0 5.0		1.5 1.0 7.0	2.5	2.5 2.5 5.0	1.5	2.5	3.5 2.5 5.0	
A-4	"	4	5-10 10-20 30	16.5	5.0	4.5	6.5	2.0 1.5 11.0	2.0	2.0 4.5 6.0	2.0	4.0	47.5 10.5 9.5		2.0 1.0 8.0	4.0	5.0 5.0 6.0	2.0	3.0	3.5 2.0	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	17.5	5.0	4.0	4.5	1.5 1.0 9.5	2.5	3.5 3.5 5.0	3.5	5.5	6.0 5.5 6.5		3.5 6.0 11.0	3.0	4.0 5.0 5.0	2.0	2.5	2.5 4.5	
B-3	"	3	5-10 10-20 30	17.5	5.5	3.0	4.0	4.0 2.0 13.5	2.5	2.0 2.5 4.0	2.5	10.0	6.5 4.5 6.0		2.5 2.5 10.0	2.5	3.0 4.0 4.0	4.5	3.0	3.0 4.0	
B-4	"	4	5-10 10-20 30	20.5	6.0	3.0	4.5	3.5 4.5 18.5	4.0	2.5 5.0 7.5	4.5	3.5	3.0 4.0 6.5		2.0 4.5 9.0	4.0	4.0 4.0 7.5	4.5	2.5	2.0 2.0	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	18.0	8.5	8.0	6.5	3.5 4.5 12.0	5.0	4.0 6.5 8.5	7.0	6.0	12.5 8.0 14.0		5.5 2.0 14.0	5.5	6.0 5.0 8.5	4.5	6.0	4.0 5.0	
C-3	"	3	5-10 10-20 30	19.0	5.5	4.5	5.0	5.0 11.0 11.0	5.0	4.0 6.5 7.5	19.0	13.5	11.0 7.0 7.0		6.0 9.0 12.0	6.0	7.0 9.0 7.5	4.0	5.5	5.0 5.5	
C-4	"	4	5-10 10-20 30	20.0	7.5	5.5	6.0	7.0 10.5 8.0	7.5	5.0 7.0 7.0	22.0	25.0	18.5 16.0 14.0		5.5 8.0 8.0	5.5	6.0 5.0 7.0	5.0	5.0	5.5 5.0	

Table 53. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5-10 10-20 30	36.0	21.5	7.0	12.0	9.5 7.0 12.0	7.5	12.5 12.0 6.5	30.5	13.0	18.5 18.5 20.0		9.5 11.0 13.5	10.0	9.0 7.0 6.5	8.5	8.5	10.0 7.5	
D-2	"	2	5-10 10-20 30	43.0	12.5	14.0	15.5	9.0 8.5 9.5	8.5	8.5 8.0 10.0	18.0	12.5	15.5 16.0 16.5		11.0 8.5 9.0	9.5	10.0 9.5 10.0	9.5	10.0	12.0 8.5	
D-3	"	3	5-10 10-20 30	29.0	15.0	13.5	16.0	7.0 6.5 13.0	6.5	4.0 9.0 12.0	12.5	16.0	9.5 11.0 13.0		9.0 9.5 16.0	12.5	11.0 7.5 12.0	9.0	10.5	9.0 10.5	
E-1	Ash + low moor peat + NPK	1	5-10 10-20 30	23.5	7.5	10.5	10.0	4.0 5.0 4.5	6.0	5.0 5.0 5.0	30.0	22.0	20.5 17.0 9.5		4.5 7.0 6.5	6.0	5.0 4.5 5.0	6.0	6.5	8.0 6.0	
E-2	"	2	5-10 10-20 30	20.0	8.0	9.0	13.5	4.5 6.0 8.5	6.0	5.5 5.0 7.0	6.0	16.0	21.5 22.0 16.0		5.0 4.5 8.5	8.0	7.0 6.5 7.0	8.0	7.5	6.5 4.5	
E-3	"	3	5-10 10-20 30	18.0	9.0	8.5	8.0	4.5 10.0 10.0	6.5	6.0 7.0 6.0	7.5	15.0	19.5 23.5 31.0		7.0 8.0 8.0	7.0	7.0 6.0 6.0	8.5	8.0	6.5 4.5	
F-1	Ash + high moor peat + NPK	1	5-10 10-20 30	16.0	9.0	9.0	9.0	6.0 6.5 11.5	7.5	8.0 8.0 8.5	11.0	16.5	9.5 12.0 8.0		7.0 10.0 10.5	6.5	8.5 9.0 8.5	9.5	8.0	5.0 5.0	
F-2	"	2	5-10 10-20 30	15.0	12.0	8.5	10.0	5.5 9.5 16.0	8.0	6.5 6.5 9.5	16.5	21.5	21.0 16.5 12.0		9.0 9.0 14.0	8.0	7.0 9.0 9.5	9.0	8.0	6.5 7.5	
F-3	"	3	5-10 10-20 30	13.5	10.0	8.0	9.0	7.0 9.5 14.0	7.5	7.0 6.5 12.5	8.0	11.5	17.0 15.0 15.5		9.0 9.5 14.5	7.5	7.5 8.5 12.5	7.0	7.0	7.5 7.0	
G-1	Ash + farm manure + NPK	1	5-10 10-20 30	20.5	11.0	9.5	11.0	6.0 10.5 15.0	7.5	6.5 9.0 11.0	4.5	19.0	26.5 30.5 24.5		8.0 9.0 17.5	7.5	11.5 9.5 11.0	4.5	5.0	6.0 9.5	
G-2	"	2	5-10 10-20 30	24.0	9.5	9.5	10.0	11.0 8.0 13.0	6.0	7.0 16.0 10.0	8.0	7.0	14.0 16.0 16.5		8.5 14.5 12.5	7.5	10.0 11.5 10.0	8.0	6.0	7.0 5.5	
G-3	"	3	5-10 10-20 30	30.0	11.5	9.0	10.5	6.5 14.0 15.0	6.5	4.5 6.5 11.0	16.5	15.0	17.5 16.0 13.0		9.5 10.5 17.5	11.0	7.5 10.0 11.0	8.0	8.5	10.5 7.5	
H-1	Ash + N2PK	1	5-10 10-20 30	30.0	10.0	10.0	10.0	7.0 9.0 15.0	8.0	7.0 7.0 6.5	10.0	14.5	22.0 13.5 14.0		7.5 5.5 8.5	8.5	5.0 5.0 6.5	7.0	15.0	10.0 5.5	
H-2	"	2	5-10 10-20 30	22.5	10.5	10.0	8.5	8.0 13.0 11.5	8.0	6.5 6.5 6.5	17.0	18.0	27.5 19.0 22.0		12.0 11.5 14.5	8.0	6.5 6.0 6.5	9.0	7.5	10.0 7.5	
H-3	"	3	5-10 10-20 30	22.0	8.5	7.5	9.0	6.5 6.0 9.5	7.0	5.0 6.0 6.5	14.0	17.0	11.5 9.0 8.0		6.0 7.5 17.0	7.5	6.0 5.0 6.5	6.0	10.0	8.0 7.0	
..	..																				

Table 53. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5–10 10–20 30	18.5	10.5	9.0	12.5	8.0 9.0 15.0	5.5	7.5 7.5 14.0	10.0	22.5	12.5 13.0 14.4		11.0 9.5 11.0	7.5	6.5 15.0 14.0	9.5	8.0	10.0 11.0	
I-2	"	2	5–10 10–20 30	22.0	10.0	10.0	10.0	10.5 14.5 17.0	8.5	11.5 11.5 16.0	26.0	15.5	10.5 17.0 14.0		10.5 15.0 17.5	6.0	11.0 8.5 16.0	10.0	8.0	8.5 7.5	
I-3	"	3	5–10 10–20 30	15.0	11.0	11.5	10.0	6.0 6.5 11.0	5.5	5.0 7.0 6.5	26.5	10.5	15.0 17.5 10.5		8.0 9.0 12.5	12.0	7.0 7.5 6.5	6.0	6.5	7.5 7.5	
0-1	Ash without fertilization till 1976 (control)	1	5–10 10–20 30	12.0	11.5	10.0	13.0	7.5 6.0 11.5	5.0	4.5 4.0 6.0	18.5	14.0	22.0 28.5 20.0		7.0 6.5 6.5	5.0	6.0 7.0 6.0	6.0	7.0	8.0 6.5	
0-2	"	2	5–10 10–20 30	12.5	8.5	9.0	10.5	6.5 9.5 20.0	19.5	7.5 6.0 6.0	17.5	20.0	14.0 14.0 10.0		7.5 7.0 18.5	7.0	7.5 7.5 6.0	10.0	7.5	8.0 6.5	
0-3	"	3	5–10 10–20 30	10.5	10.0	8.0	10.0	7.5 7.0 13.0	7.5	6.0 7.5 8.5	29.0	17.0	18.0 13.5 11.5		8.5 7.5 11.0	7.0	8.5 10.0 8.5	7.5	7.5	8.0 6.5	

Note: 1) S - Spring
a - Fall

2) Figures in col. 3
denote cultivation of:
1 - lucerne with
orchard grass
2 - mixture of grasses
with legumes
3 - lucerne with orchard
grass
4 - sweetclover

Content of K_2O in produced ash soils
Konin

Table 54

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of K_2O [mg/100 g of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				s	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5–10 10–20 30	9.5	10.5	7.5	8.0	3.5 2.5 1.5	2.5	4.0 2.5 3.0	4.0	24.0	15.5 4.5 3.5		4.0 2.5 1.5	2.5	3.5 3.5 3.0	4.0	5.0	4.5 3.5	
A-3	"	3	5–10 10–20 30	7.5	3.0	17.5	4.0	2.5 2.5 2.5	3.0	3.0 3.0 2.0	2.5	25.5	10.0 3.5 2.5		3.0 3.5 2.5	3.0	3.5 3.0 2.0	4.0	5.0	2.0 4.5	
A-4	"	4	5–10 10–20 30	9.5	8.0	9.5	4.5	3.0 2.0 1.5	6.5	3.5 3.0 2.5	5.0	18.0	8.5 5.0 3.0		1.5 2.0 1.5	4.5	3.5 3.5 2.5	6.0	9.0	9.0 3.5	
B-2	Ash + 10 cm of fertile soil + NPK	2	5–10 10–20 30	10.0	7.5	7.0	3.5	2.5 2.0 5.0	3.5	3.0 2.5 2.0	3.0	10.5	10.0 10.5 9.5		3.0 5.0 5.0	3.0	4.5 4.0 2.0	5.5	8.0	7.5 3.5	
B-3	"	3	5–10 10–20 30	7.5	5.0	7.5	7.5	2.5 2.5 4.5	4.5	3.0 2.5 3.0	3.0	13.0	15.5 4.0 3.0		4.0 3.0 4.5	3.0	3.0 2.0 3.0	3.5	3.5	2.0 1.5	
B-4	"	4	5–10 10–20 30	12.0	4.0	7.0	6.5	2.5 3.0 2.0	4.0	3.0 2.5 3.0	3.0	10.0	22.0 4.5 3.5		3.0 3.5 2.0	3.5	4.0 3.5 3.0	7.5	7.5	7.5 4.0	
C-2	Ash + 5 cm of fertile soil + NPK	2	5–10 10–20 30	8.5	10.0	14.0	3.0	2.5 2.5 2.5	3.5	1.5 1.0 1.0	2.0	18.5	43.5 29.0 7.5		1.5 1.5 2.5	8.5	2.5 2.5 1.0	6.0	7.0	6.5 5.0	
C-3	"	3	5–10 10–20 30	12.5	8.5	9.5	19.0	2.0 1.0 1.0	3.5	3.0 1.5 1.5	4.5	7.0	8.0 2.5 3.0		1.5 2.0 1.0	3.5	2.0 1.5 1.5	2.5	3.0	5.0 5.0	
C-4	"	4	5–10 10–20 30	22.5	8.0	14.5	9.5	5.5 4.0 4.5	4.0	1.5 2.0 3.0	3.0	17.5	35.0 12.0 2.5		7.0 3.5 4.5	4.5	4.5 5.5 3.0	5.0	11.0	5.0 3.0	
.. .	.. .																				

Table 54. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + tertiary sand + NPK	1	5–10 10–20 30	11.0	6.0	4.5	3.0	5.0 4.0 3.0	3.0	4.0 4.5 3.5	1.5	10.0	15.5 4.5 4.0		1.5 2.5 3.0	1.0	3.0 3.5 3.5	4.5	5.5	5.5 6.5	
D-2	"	2	5–10 10–20 30	14.0	4.5	5.0	1.0	1.5 1.0 1.0	3.0	2.0 2.5 1.5	12.0	16.0	10.0 4.0 2.5		1.5 2.0 1.0	3.0	1.5 2.5 1.5	3.0	5.0	6.0 2.5	
D-3	"	3	5–10 10–20 30	20.0	2.5	4.0	2.0	1.5 3.5 3.0	2.5	1.5 2.0 2.5	4.0	12.5	9.0 3.0 3.5		1.5 3.5 3.0	1.0	2.0 3.0 2.5	2.0	2.5	3.5 2.0	
E-1	Ash + low moor peat + NPK	1	5–10 10–20 30	26.0	17.5	14.5	18.5	16.5 10.5 5.0	12.5	3.5 3.0 3.0	5.0	13.0	34.5 10.5 9.0		13.0 7.5 5.0	9.5	6.5 5.5 3.0	10.5	4.0	13.5 11.0	
E-2	"	2	5–10 10–20 30	29.5	23.0	21.0	17.5	4.5 3.5 5.0	6.0	4.0 3.0 4.5	2.0	8.0	4.5 3.5 3.0		10.0 6.5 5.0	8.5	5.5 4.5 4.5	2.5	14.5	10.0 13.5	
E-3	"	3	5–10 10–20 30	30.5	29.5	22.5	23.5	6.0 3.5 6.0	7.0	6.0 3.5 6.0	5.5	14.0	202.5 120.0 57.0		11.5 6.5 6.0	9.5	6.0 6.0 6.0	7.5	5.0	9.5 5.5	
F-1	Ash + high moor peat + NPK	1	5–10 10–20 30	35.5	34.0	19.5	27.5	13.5 10.0 9.5	12.5	8.0 7.0 8.0	10.0	15.0	13.5 6.0 5.5		10.0 7.5 9.0	10.0	8.5 9.5 8.0	7.0	10.0	10.0 5.0	
F-2	"	2	5–10 10–20 30	18.5	25.5	20.5	23.5	11.0 8.5 9.0	9.0	4.0 6.5 17.0	2.0	10.0	33.0 8.0 6.5		9.5 6.5 9.0	8.5	6.0 5.0 17.0	9.5	8.5	10.0 6.5	
F-3	"	3	5–10 10–20 30	31.0	30.0	21.5	13.5	10.5 7.5 7.0	8.0	3.5 3.0 3.0	5.5	27.5	20.5 6.0 7.0		6.0 3.5 7.0	10.0	4.0 3.5 3.0	3.0	14.5	21.0 12.0	
G-1	Ash + farm manure + NPK	1	5–10 10–20 30	55.0	36.0	23.5	16.0	8.5 13.0 10.0	17.5	8.0 7.0 11.0	13.0	34.0	18.5 5.5 6.0		11.0 8.0 10.0	20.5	17.0 15.0 11.0	19.0	19.5	16.0 8.5	
G-2	"	2	5–10 10–20 30	40.0	41.5	31.0	22.0	12.0 11.5 6.5	7.5	6.0 3.0 4.0	5.0	16.5	14.5 11.0 10.0		9.0 5.0 6.5	6.0	6.0 5.0 4.0	10.5	7.5	25.5 17.5	
G-3	"	3	5–10 10–20 30	62.0	23.0	27.5	28.0	7.0 5.0 8.0	9.5	7.0 5.5 13.5	11.0	12.5	41.0 11.0 11.5		11.5 10.0 8.0	20.5	2.5 2.0 13.5	20.0	10.5	18.5 15.0	
H(K)-1	Ash + N2PK + green manure (corn)	1	5–10 10–20 30	24.0	21.5	13.0	15.0	10.0 12.5 8.5	11.5	9.5 12.5 12.5	33.5	11.0	45.5 23.5 22.0		20.5 11.5 8.5	24.0	14.5 17.0 12.5	11.0	17.0	16.0 11.5	
H(K)-2	"	2	5–10 10–20 30	20.0	20.5	17.0	14.0	20.0 [illegible] 28.0	17.0	6.5 6.5 10.0	4.0	20.5	16.0 6.0 5.5		20.0 11.5 28.0	10.5	11.0 9.5 10.0	23.5	17.5	14.5 10.0	
H(K)-3	"	3	5–10 10–20 30	25.5	24.5	19.0	16.0	16.0 13.5 12.0	21.5	6.5 5.5 5.0	3.5	6.0	7.5 35.0 6.5		13.0 9.0 12.0	15.0	13.5 21.5 5.0	8.0	8.0	11.5 7.0	
..	.. .																				

Table 54. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5–10 10–20 30	33.0	38.0	19.5	17.5	20.0 12.5 9.5	19.0	7.0 5.5 6.5	8.0	21.0	24.5 9.5 13.0		11.0 13.0 9.5	12.5	11.0 12.5 6.5	10.0	9.0	14.5 9.0	
I-2	"	2	5–10 10–20 30	26.0	17.5	25.0	20.0	11.0 10,5 16.5	9.5	4.0 6.0 11.0	5.5	36.0	21.0 7.0 6.5		18.0 10.5 16.5	10.0	9.5 7.5 11.0	10.0	17.5	10.0	
I-3	"	3	5–10 10–20 30	20.5	18.0	22.0	21.5	19.0 12.5 20.0	14.5	8.5 8.0 10.0	9.0	5.5	14.0 5.5 5.0		13.5 8.0 20.0	17.5	13.0 11.5 10.0	11.0	10.5	10.5 8.0	
0-1	Ash without fertilization till 1976 (control)	1	5–10 10–20 30	33.0	14.0	17.0	11.5	20.0 17.0 11.5	11.0	4.5 3.5 3.5	13.5	13.5	49.0 23.0 14.0		15.0 7.5 11.5	10.0	15.5 14.0 12.5	12.0	11.5	11.5 7.5	
0-2	"	2	5–10 10–20 30	32.5	13.5	18.0	8.5	3.5 3.0 12.5	5.5	4.5 2.5 4.5	2.5	9.5	22.5 7.0 6.0		11.5 6.0 12.5	6.0	6.0 5.0 4.5	8.0	10.5	4.0 3.5	
0-3	"	3	5–10 10–20 30	20.0	15.0	22.0	32.0	21.0 10.5 8.0	19.0	17.0 12.0 13.0	8.0	15.0	16.0 12.5 18.0		13.0 13.5 8.0	21.5	14.0 11.0 13.0	6.5	22.0	16.5 15.2	

Note: 1) S - Spring
a - Fall
2) Figures in col. 3 denote cultivation of:
1 - sainfoin with crown vetch
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Content of soluble boron in produced ash soils
Halemba

Table 55

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of boron [mg/kg of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				s	a	s	a	s	a	s	s	a	s	a	s	a	s	s	a	s	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5–10 10–20 30	0.8	0.5	2.1	0.4	0.4 0.4 2.9	0.4	0.5 0.5 2.0	0.9	2.5	0.6 0.8 1.1		0.3 0.7 0.9	0.3	0.2 0.5 2.0	0.4	1.1	0.6 1.0 1.1	–
A-3	"	3	5–10 10–20 30	0.6	0.5	1.5	0.5	0.4 0.4 1.7	0.3	0.3 0.5 1.5	0.5	1.2	0.6 1.3 1.5		0.4 0.4 1.5	0.3	0.3 0.2 1.5	0.3	0.5	0.4 0.5 1.5	
A-4	"	4	5–10 10–20 30	1.4	0.8	3.0	0.6	0.3 0.4 3.0	0.4	0.3 1.0 1.3	0.5	0.7	2.9 1.7 1.7		0.3 0.4 1.7	0.5	0.6 0.6 1.3	0.4	0.6	0.6 0.6 1.7	
B-2	Ash + 10 cm of fertile soil + NPK	2	5–10 10–20 30	1.5	0.5	3.3	0.7	0.4 0.5 1.8	0.4	0.7 0.6 0.8	0.2	1.0	0.4 0.5 1.5		0.4 1.1 1.9	0.7	0.5 1.0 0.8	0.3	0.7	0.7 1.1 1.5	
B-3	"	3	5–10 10–20 30	1.7	0.9	1.7	0.8	0.8 0.6 1.6	0.4	0.5 0.6 0.6	1.0	2.0	0.9 1.2 1.3		0.3 0.5 1.8	0.8	0.3 0.6 0.6	0.7	0.3	0.4 0.7 1.3	
B-4	"	4	5–10 10–20 30	1.8	0.8	1.4	0.7	0.7 1.3 2.3	0.7	0.8 1.1 2.3	1.0	0.7	0.8 1.2 2.2		0.3 0.9 1.5	0.6	0.3 0.9 1.3	0.5	1.2	0.6 0.4 1.2	
C-2	Ash + 5 cm of fertile soil + NPK	2	5–10 10–20 30	1.5	1.9	1.2	0.7	0.8 0.8 1.4	0.6	0.4 0.8 1.3	0.9	2.1	1.2 1.0 0.7		0.7 0.4 1.4	0.7	0.6 0.8 1.3	0.6	0.7	1.1 0.7 0.7	
C-3	"	3	5–10 10–20 30	1.2	1.0	1.2	0.5	0.8 2.7 3.7	0.8	0.8 1.2 2.4	1.2	1.7	1.2 1.4 1.5		0.7 0.8 3.2	0.6	0.6 0.9 2.4	0.6	0.6	0.8 1.0 1.5	
C-4	"	4	5–10 10–20 30	1.3	1.4	1.2	0.7	0.9 1.5 3.3	0.8	0.9 0.9 3.0	1.5	2.4	1.9 2.5 3.0		0.8 1.1 3.4	0.6	0.8 0.7 3.0	0.7	0.6	0.9 1.1 3.0	

Table 55. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5–10	1.3	1.4	1.1	0.8	1.3	1.8	1.3	1.0	1.4	1.6		0.8	0.6	0.7	0.7	0.6	1.0	
			10–20					3.4		3.3			2.4		1.1		0.9			1.0	
			30					1.3		4.8			2.2		0.8		4.8			2.2	
D-2	"	2	5–10	1.2	1.2	2.9	0.7	2.1	1.0	1.8	0.9	1.8	1.6		0.8	0.5	0.7	0.7	0.6	1.0	
			10–20					2.5		3.4			1.9		3.6		4.1			1.4	
			30					4.1		3.1			2.5		3.9		3.1			2.5	
D-3	"	3	5–10	1.4	1.0	1.2	0.8	0.8	0.7	1.1	1.4	1.3	1.4		1.4	0.7	1.5	0.5	0.6	0.8	
			10–20					2.1		1.3			1.7		3.2		3.4			1.3	
			30					4.6		1.4			1.5		4.0		1.4			1.5	
E-1	Ash + low moor peat + NPK	1	5–10	1.5	1.4	0.9	0.8	1.0	0.7	0.8	2.0	2.0	1.4		1.1	0.7	0.8	0.8	1.1	0.9	
			10–20					1.2		1.0			1.6		1.3		0.9			1.3	
			30					1.6		1.0			1.6		1.7		1.0			1.6	
E-2	"	2	5–10	1.4	1.9	0.9	0.7	0.9	0.7	0.5	0.9	2.0	1.2		1.1	0.7	1.0	0.6	1.0	0.9	
			10–20					1.7		0.9			1.5		1.3		0.8			1.0	
			30					2.7		0.7			1.5		2.0		0.7			1.5	
E-3	"	3	5–10	1.5	1.0	0.9	0.6	1.1	0.7	0.7	0.9	2.3	1.4		1.2	0.7	0.7	0.6	1.0	0.7	
			10–20					1.2		1.1			2.3		1.2		0.7			0.8	
			30					1.3		0.7			2.1		1.6		0.7			2.1	
F-1	Ash + high moor peat + NPK	1	5–10	1.4	1.4	1.1	0.6	0.9	0.6	0.7	1.7	2.0	1.1		1.1	0.6	0.6	0.7	1.0	0.8	
			10–20					1.2		0.8			1.4		1.3		0.8			0.7	
			30					1.5		1.0			1.6		1.9		1.0			1.6	
F-2	"	2	5–10	1.1	1.9	1.1	0.7	0.9	0.8	0.7	1.1	1.9	1.3		0.9	1.7	0.5	0.9	0.6	0.9	
			10–20					1.2		0.9			1.2		1.1		0.7			0.8	
			30					3.7		1.0			1.6		3.0		1.0			1.6	
F-3	"	3	5–10	1.3	1.0	0.9	0.7	1.3	0.8	0.6	0.8	1.4	1.3		1.5	0.8	0.5	0.8	0.8	0.6	
			10–20					1.4		0.7			1.4		1.5		0.7			0.6	
			30					2.0		1.2			1.3		2.7		1.2			1.3	
G-1	Ash + farm manure + NPK	1	5–10	1.5	2.8	0.9	0.8	1.2	0.8	0.6	0.9	1.9	1.1		1.1	0.7	1.0	0.8	1.0	0.9	
			10–20					1.9		1.2			1.6		1.3		1.1			1.1	
			30					2.7		1.5			1.8		5.3		1.5			1.8	
G-2	"	2	5–10	1.6	1.9	1.1	1.2	0.9	0.7	1.1	1.0	0.8	1.1		0.5	0.6	0.8	1.1	0.8	0.7	
			10–20					1.9		1.6			1.6		2.6		1.3			1.0	
			30					4.2		1.1			1.6		4.0		1.1			1.6	
G-3	"	3	5–10	1.6	1.1	1.1	1.0	0.7	0.4	0.4	1.4	1.5	1.2		0.9	0.7	0.9	0.7	0.8	0.8	
			10–20					1.3		1.3			1.8		1.4		1.4			0.9	
			30					1.7		1.2			2.1		4.7		1.2			2.1	
H-1	Ash + N2PK	1	5–10	1.2	1.2	0.9	0.6	0.6	0.7	0.7	1.5	1.5	1.3		0.8	0.6	0.6	1.0	1.8	0.7	
			10–20					0.9		0.9			1.4		0.5		0.6			0.8	
			30					2.0		1.1			1.2		1.5		1.1			1.2	
H-2	"	2	5–10	0.8	1.0	0.9	0.5	1.1	0.7	0.6	1.0	2.2	1.3		0.9	0.5	0.4	0.5	1.0	0.6	
			10–20					1.6		0.7			1.3		1.3		0.7			0.9	
			30					3.2		0.9			2.5		3.2		0.9			2.5	
H-3	"	3	5–10	0.8	1.4	1.1	0.5	0.9	0.5	0.7	1.1	1.4	1.0		0.8	0.5	0.7	0.5	0.6	0.7	
			10–20					0.8		0.8			1.1		0.9		0.8			0.9	
			30					1.7		1.0			1.3		5.2		1.0			1.3	

Table 55. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10 10-20 30	1.4	1.9	1.2	0.8	1.0 1.5 8.6	1.2	1.0 1.6 9.5	1.1	1.0	1.1 2.7 2.1		1.1 2.2 3.2	0.7	1.0 1.3 9.5	0.6	1.8	1.0 1.6 2.1	
I-2	"	2	5-10 10-20 30	1.2	2.2	1.2	0.8	1.1 1.2 3.4	2.0	1.1 1.6 5.7	2.0	1.8	1.6 1.9 2.1		1.4 3.2 3.8	0.8	0.8 1.3 5.0	0.8	2.2	1.2 0.4 2.1	
I-3	"	3	5-10 10-20 30	1.2	2.2	1.4	1.0	1.0 1.2 1.8	1.3	1.0 1.1 1.2	1.7	1.4	1.3 1.6 2.1		0.9 1.0 2.1	1.5	0.8 1.7 6.9	0.9	0.9	1.1 1.0 2.1	
0-1	Ash without fertilization till 1976 (control)	1	5-10 10-20 30	1.6	1.4	1.4	1.1	1.0 1.0 1.4	0.8	0.8 1.1 1.3	1.9	1.9	1.4 1.7 2.9		0.8 1.1 1.1	0.9	0.9 0.9 1.3	1.0	0.7	1.0 1.1 2.9	
0-2	"	2	5-10 10-20 30	0.9	1.4	1.2	0.8	1.0 1.1 2.5	0.8	0.6 0.8 1.1	1.1	2.2	1.4 1.3 1.4		0.8 0.9 1.4	0.6	1.3 0.5 1.1	0.9	0.6	0.8 0.7 1.4	
0-3	"	3	5-10 10-20 30	1.5	1.9	1.1	1.2	1.0 1.3 3,8	0.7	1.1 0.9 1.3	1.8	1.9	1.1 1.2 1.5		0.9 1.3 9.3	0.6	0.7 0.8 1.3	0.6	0.7	1.3 1.0 1.5	

Note: 1) S - Spring
a - Fall
2) Figures in col. 3 denote cultivation of:
1 - lucerne with sweetclover
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Table 56

Content of soluble boron in produced ash soils

Konin

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of boron [mg/kg of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5–10 10–20 30	0,6	0.5	1.1	1.4	0.5 0.4 22.5	0.8	6.3 1.5 4.0	0.9	2.2	1.2 1.2 3.5		1.1 4.5 22.5	12.0	2.3 1.5 4.5	1.0	1.8	0.8 0.8 3.5	
A-3	"	3	5–10 10–20 30	0,9	0.7	2.3	0.7	0.9 0.9 18.5	0.8	0.8 0.8 25.5	0.8	2.8	1.3 1.1 12.2		0.8 0.8 18.5	0.8	1.9 4.5 25.5	1.2	0.9	1.3 1.8 2.2	
A-4	"	4	5–10 10–20 30	0.9	0.8	1.8	2.5	0.9 15.0 22.5	2.4	1.4 1.5 21.5	2.8	3.5	1.6 1.7 16.0		1.8 8.8 22.5	1.6	1.3 1.0 21.5	0.9	1.2	2.0 1.2 16.0	
B-2	Ash + 10 cm of fertile soil + NPK	2	5–10 10–20 30	3.5	5.2	1.8	1.2	2.2 13.5 21.7	2.4	2.0 9.8 21.5	2.7	2.9	2.3 2.3 5.7		9.8 24.0 21.7	4.5	9.0 15.5 21.5	1.1	1.1	1.8 3.5 5.7	
B-3	"	3	5–10 10–20 30	0.7	0.8	1.8	1.2	3.4 18.5 20.5	7.5	3.5 15.0 26.5	5.2	2.2	1.6 1.5 1.9		16.5 30.5 30.5	1.7	8.0 20.5 26.5	2.8	1.2	10.0 3.2 1.9	
B-4	"	4	5–10 10–20 30	2.2	1.0	2.5	5.3	2.4 7.2 29.5	2.9	2.0 18.5 22.5	1.2	3.6	2.0 14.0 14.5		2.4 19.5 29.5	1.0	14.0 29.0 22.5	3.8	3.6	1.5 1.0 14.5	
C-2	Ash + 5 cm of fertile soil + + NPK	2	5–10 10–20 30	5.0	1.2	10.2	4.4	4.0 23.5 18.5	6.5	22.0 24.5 36.0	8.4	4.2	5.5 20.0 24.0		9.8 29.5 29.5	1.7	8.5 25.0 36.0	1.6	8.6	1.5 14.0 24.0	
C-3	"	3	5–10 10–20 30	4.0	12.0	2.9	14.0	16.5 24.5 20.3	3.5	9.8 25.0 21.2	4.4	7.6	6.5 11.0 18.3		17.5 26.0 20.5	4.5	13.8 36.0 36.0	6.8	4.2	15.0 4.0 18.3	
C-4	"	4	5–10 10–20 30	5.0	11.5	2.5	11.5	13.0 18.5 23.5	12.5	36.0 15.0 45.0	15.0	4.9	5.0 1.5 14.5		14.0 30.5 23.5	0.8	38.0 20.5 45.0	12.0	7.0	15.0 32.0 14.5	
..	...																				

Table 56. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + tertiary sand + NPK	1	5–10 10–20 30	6.0	8.0	10.3	3.3	7.5 22.0 25.5	6.0	1.2 17.0 25.0	14.0	9.8	29.8 11.0 20.0		11.5 29.5 25.5	0.9	26.0 30.0 25.0	17.5	10.4	6.0 12.8 20.0	
D-2	"	2	5–10 10–20 30	19.5	3.0	4.4	3.4	9.0 28.0 19.5	15.5	19.0 25.0 27.0	11.1	3.6	5.0 17.5 24.0		6.0 19.5 19.5	4.5	6.0 26.0 27.0	8.0	6.9	10.8 18.2 24.0	
D-3	"	3	5–10 10–20 30	26.5	6.2	10.2	5.5	34.5 25.5 27.0	11.5	3.6 21.0 32.0	10.0	3.5	10.0 12.2 37.8		9.0 16.0 27.0	3.0	17.0 29.0 32.0	7.0	4.2	21.0 10.8 37.8	
E-1	Ash + low moor peat + NPK	1	5–10 10–20 30	25.0	31.2	28.4	27.5	29.5 22.5 25.0	15.0	24.0 30.0 7.0	20.0	15.6	11.0 13.8 15.0		29.0 13.5 25.0	16.5	23.2 24.0 15.5	16.0	17.6	18.5 10.0 15.0	
E-2	"	2	5–10 10–20 30	28.8	30.5	36.0	26.5	22.0 24.0 27.0	22.5	27.5 29.0 22.8	23.0	18.2	11.5 10.5 18.5		24.0 25.0 27.0	21.5	35.0 25.2 22.8	26.5	23.8	20.0 13.8 18.5	
E-3	"	3	5–10 10–20 30	28.8	2.5	35.2	27.0	21.0 26.5 26.5	26.5	32.5 30.0 21.2	22.0	19.0	10.5 21.8 24.0		23.0 25.0 26.5	18.0	29.0 32.2 21.2	26.0	17.0	8.0 12.5 24.0	
F-1	Ash + high moor peat + NPK	1	5–10 10–20 30	29.5	3.8	40.0	28.5	21.0 22.0 23.5	21.2	25.8 22.3 16.0	18.0	20.0	7.0 29.8 23.0		26.5 23.0 23.5	23.5	28.0 29.0 16.0	15.5	17.6	7.5 23.0 23.0	
F-2	"	2	5–10 10–20 30	33.5	2.8	36.0	31.0	25.0 25.0 25.0	17.5	16.3 17.2 16.5	18.0	21.0	9.0 21.8 25.0		24.0 22.0 25.0	16.0	27.0 17.3 16.5	23.0	20.0	12.5 18.5 25.0	
F-3	"	3	5–10 10–20 30	29.2	3.0	40.0	34.5	27.0 22.0 22.0	4.0	25.8 13.8 17.0	18.0	15.8	14.8 25.0 24.0		23.5 25.5 22.0	20.0	31.5 24.0 17.0	17.0	17.0	18.5 25.0 24.0	
G-1	Ash + farm manure + NPK	1	5–10 10–20 30	29.2	4.5	32.4	26.5	27.5 23.0 23.0	20.5	25.8 25.0 23.2	20.0	12.6	7.5 26.0 27.8		25.0 27.5 23.0	20.5	21.2 28.0 23.2	27.0	15.4	9.0 18.5 27.8	
G-2	"	2	5–10 10–20 30	36.2	1.7	28.8	31.0	22.0 28.5 22.0	25.5	27.5 27.5 15.5	20.0	16.8	19.0 21.2 31.5		18.0 24.0 22.0	22.0	27.0 29.0 18.5	20.0	16.4	5.0 17.2 31.5	
G-3	"	5-	5–10 10–20 30	37.5	1.8	31.2	30.0	23.0 24.0 20.0	25.5	30.0 31.5 21.5	20.0	17.0	10.5 23.0 18.5		26.5 24.0 22.0	17.0	27.5 32.0 21.5	13.5	23.2	14.5 16.0 18.5	
H(K)-1	Ash + N2PK + green manure (corn)	1	5–10 10–20 30	29.5	5.8	40.0	34.0	26.0 28.5 32.5	19.0	23.0 17.5 18.5	23.0	18.2	19.0 27.2 27.8		21.5 27.0 32.5	21.5	32.0 33.2 18.5	20.0	18.2	11.0 17.7 27.8	
H(K)-2	"	2	5–10 10–20 30	33.5	32.5	26.8	34.0	20.0 25.0 26.5	26.5	27.5 23.5 18.5	20.0	19.8	16.5 19.0 29.0		30.0 20.0 26.5	25.5	26.5 21.5 18.6	19.5	17.6	14.5 16.0 29.0	
H(k)-3	"	3	5–10 10–20 30	33.5	30.5	32.4	34.5	32.5 24.0 27.0	9.0	21.5 30.0 22.5	23.0	28.5	26.0 14.3 30.8		27.0 30.0 27.0	26.0	32.0 30.0 22.5	19.5	18.2	17.8 22.0 30.8	

Table 56. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5–10 10–20 30	28.7	24.0	32.4	38.5	21.0 22.5 31.0	21.5	26.0 21.5 21.5	22.0	26.0	14.5 21.2 14.0		28.5 32.5 31.0	26.5	29.0 25.5 21.5	31.5	20.5	15.0 15.5 26.0	
I-2	"	2	5–10 10–20 30	27.0	30.5	33.6	30.0	24.0 24.0 23.0	16.5	26.0 22.5 21.5	31.5	22.5	18.5 24.8 29.0		24.0 40.0 23.0	26.5	30.0 29.0 21.5	20.0	24.5	17.2 23.0 29.0	
I-3	"	3	5–10 10–20 30	28.7	23.5	40.0	30.0	27.0 24.0 21.5	19.0	25.5 17.5 16.5	24.5	24.5	17.8 21.2 30.2		32.0 25.5 21.5	21.5	26.5 16.5 16.5	28.5	20.0	25.5 24.8 30.2	
0-1	Ash without fertilization till 1976 (control)	1	5–10 10_20 30	25.0	24.5	35.2	27.5	16.5 29.0 23.5	18.5	30.0 46.0 32.0	19.5	11.5	17.5 22.0 30.2		23.5 27.0 23.5	16.0	30.0 27.0 32.0	22.0	20.0	26.2 25.5 30.2	
0-2	"	2	5–10 10–20 30	26.5	32.0	36.4	27.0	33.5 49.0 29.0	28.0	31.0 16.0 32.0	29.5	27.0	14.5 37.0 34.5		31.5 31.0 29.0	21.5	25.0 27.0 32.0	27.0	20.0	26.2 29.0 34.5	
0-3	"	3	5–10 10–20 30	27.5	30.0	39.2	29.5	23.5 24.5 29.0	17.5	34.0 35.0 17.5	24.5	19.5	14.5 20.5 24.8		29.0 27.0 29.0	19.5	25.0 26.5 35.0	20.0	29.0	16.0 24.2 24.8	

Note: 1) S - Spring
a - Fall
2) Figures in col. 3
denote cultivation
of:
1 - sainfoin with
crown vetch
2 - mixture of grasses
with legumes
3 - lucerne with orchard
grass
4 - sweetclover

Content of manganese in produced ash soils [mg/kg of soil]
Helemba

Table 57

No. of plot	Combinations of soils and fertilizers	No. of mix-ture	Sampl-ing depth cm	Measured content of manganese in soils [mg/kg of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5–10 10–20 30	29,5	27	7,5	36.5	38 36 18	19	14 14 2	20	13	12 12 11		28 40 16	32	19 16 2	22	15	24 15 11	
A-3	"	3	5–10 10–20 30	52.5	39	13	47.5	52 28 8	8	19 15 2	21	17	35 18 8		26 32 12	38	23 34 2	11	16	20 26 8	
A-4	"	4	5–10 10–20 30	54	19.5	13	14	32 38 12	12	18 10 3	25	20	18 20 8		28 26 8	17	16 8 3	21	15	8 18 8	
B-2	Ash + 10 cm of fertile soil + NPK	2	5–10 10–20 30	64	21	23	33.5	36 28 14	21	7 4 2	19	12 6 4	12		14 16 8	14	11 4 2	16	7	8 4 4	
B-3	"	3	5–10 10–20 30	50	35.5	30	23.5	14 14 16	3	5 3 3	9	11	4 4 3		26 22 8	30	14 14 3	5	10	10 10 3	
B-4	"	4	5–10 10–20 30	58	28	22	32	22 14 8	3	5 2 2	23	9	8 4 4		68 20 12	10	40 12 2	7	20	15 16 4	
C-2	Ash + 5 cm of fertile soil + NPK	2	5–10 10–20 30	45	5.5	7	7.5	8 12 8	0	12 2 1	2	6	2 2 1		12 28 8	7	9 4 1	7	2	8 4 1	
C-3	"	3	5–10 10–20 30	41	9	7.5	16	12 8 8	0	7 4 4	3.	7	1 1 2		12 12 8	5	9 7 4	2	6	2 8 2	
C-4	"	4	5–10 10–20 30	13	2	3.5	4.5	8 8 8	0	6 4 0	1	3	2 2 1		8 8 8	0	5 2 0	1	5	1 1 1	
..	..																				

Table 57. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5–10 10–20 30	0.5	1	3.5	2.5	8 8 8	9	4 0 2	2	2	1 1 1		8 8 8	2	4 11 2	1	3	4 3 1	
D-2	"	2	5–10 10–20 30	0.0	0	2	5	6 7 6	0	5 2 4	1	2	1 1 1		10 6 6	0	5.5 5 4	2	2	2 1 1	
D-3	"	3	5–10 10–20 30	0.0	0	2.5	2.5	6 7 6	0	4.5 2 2	1	3	1 1 1		7 6 7	0	4 1 2	1	3	4 1 1	
E-1	Ash + low moor peat + NPK	1	5–10 10–20 30	2	1	3	2	11.5 10 8	0	9 5 9	5	4	4 2 3		13.5 11.5 12	0	7 9 9	3	3	3 3 3	
E-2	"	2	5–10 10–20 30	1	1	2.5	3	13 11.5 11.5	0	9 9 9	3	3	2 3 2		11.5 10 8	0	5 9 9	1	1	2 4 2	
E-3	"	3	5–10 10–20 30	0.5	1	2	2.5	11.5 13 10	1	90 5 7	1	1	5 4 4		10 11.5 8	0	7 7 7	2	0	3 4 4	
F-1	Ash + high moor peat + NPK	1	5–10 10–20 30	0	0	1.5	1.5	3 10 8	2	5 9 4	2	2	2 3 2		8 10 10	0	11 5 4	1	0	5 7 2	
F-2	"	2	5–10 10–20 30	0	0	1	1	11.5 13.5 8	0	5 4 5	6	4	2 2 2		11.5 10 10	0	7 11 5	2	0	2 2 2	
F-3	"	3	5–10 10–20 30	0	0	2	1	9 10 8	0	9 2 5	2	4	2 2 1		9 8 7	0	2 7 5	1	1	2 0 1	
G-1	Ash + farm manure	1	5–10 10–20 30	0	0	1	1	9 10 8	0	4 7 5	1	3	2 0 2		10 11.5 10	0	9 5 5	1	1	2 2 2	
G-2	"	2	5–10 10–20 30	0	0	1.5	1	10 8 7	0	6 4.5 4	1	1	2 4 2		10 8 8	0	5.5 5 4	1	0	2 2 2	
G-3	"	3	5–10 10–20 30	0	0	2	1	10 9 8	0	4 5 4	4 1	2	4 1 1		11.5 11.5 8	0	4 4 4	1	0	2 2 1	
H-1	Ash + N2PK	1	5–10 10–20 30	0	0.5	2.5	1.5	14 11.5 8	0	12 5 11	1	4	5 4 2		11.5 12 10	0	5 11 11	1	1	3 2 2	
H-2	"	2	5–10 10–20 30	0	0.5	2.5	2	10 8 7	0	6 9 4.5	1	7	3 4 3		8 8 7	3	4 8.5 4.5	2	1	2 2 3	
H-3	"	3	5–10 10–20 30	0	0	2.5	2.5	10 10 8	0	9 4.5 9	1	3	4 2 3		8 10 7	3	9 9 9	1	0	3 2 3	

Table 57. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5–10 10–20 30	0	0	1	1	7 8 7	0	6 6 5	1	3	3 1 1		7 6 7	0	1 4 5	1	1	1 1 1	
I-2	"	2	5–10 10–20 30	0	0	1	1	7 8 8	0	2 4 2	1	3	4 2 2		7 7 7	0	8 2 2	1	3	2 1 2	
I-3	"	3	5–10 10–20 30	0	0	1	1	7 7 10	0	6 4 8	1	5	2 2 2		10 8 8	0	8 5 8	1	3	4 2 2	
0-1	Ash without fertilization till 1976 (control)	1	5–10 10–20 30	0	0	2	1.5	8 10 8	0	6 9 3	2	4	3 4 4		11 10 10	0	9 4.5 3	1	3	4 2 4	
0-2	"	2	5–10 10–20 30	0	0	1.5	1.5	10 8 8	0	4 8 8	1	5	4 4 4		13 13 8	0	4 6 8	1	3	3 8 4	
0-3	"	3	5–10	0	0	1	1	10 10 7	0	10 9 9	1	6	4 4 2		10 10 7	0	6 5 9	1	1	2 2 2	

Note: 1) S - Spring
a - Fall
2) Figures in col. 3
denote cultivation of:
1 - lucerne with sweet-clover
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Content of manganese in produced ash soils [mg/kg of soil]

Konin

Table 58

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of manganese in soils [mg/kg of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				S	a	S	a	S	a	S	S	a	S	a	S	a	S	S	a	S	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	13	16	12	9	10 4 4	14	27 4 2	25	35	10 6 4		1 4 4	12	13 11 2	20	21	8 10 4	
A-3	"	3	5-10 10-20 30	9	17	10	10.5	4 14 0	10	19 25 6	30	35	8 4 4		8 7 0	14	17 6 6	16	23	8 5 4	
A-4	"	4	5-10 10-20 30	11	14.5	7.5	7.5	13 0 2	0	22 17 4	15	20	17 7 6		1 2 2	12	16 6 4	31	22	8 10 6	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	3	2.5	9	9.5	0 3 0.5	2	21 16 7	15	19.5	12 7 6		5 1 0.5	4	1 5 7	17	22	6 2 6	
B-3	"	3	5-10 10-20 30	9	10.5	10	7	7 0 1	11	16 1 15	12	27	3 4 4		0 5 1	6	9 5 15	13	19	7 4 4	
B-4	"	4	5-10 10-20 30	5.5	10.5	6	4	1 7 0.5	0	9 1 0	25	14	2 4 5		2 0 0.5	13	7 1 0	12	11	5 4 5	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	1	10.5	8.5	3	1 0 3	0	6 1 1	8	17	4 2 4		0 5 3	15	8 9 1	14	5	10 6 4	
C-3	"	3	5-10 10-20 30	1	3	4.5	3	0 3 0	0	8.5 10 8	11	6	4 3 2		0 0 0	4	2.5 9 8	5	8	5 4 2	
C-4	"	4	5-10 10-20 30	1	1.5	7.5	3	2 0 2	0	5.5 5.5 2.5	6	10	6 7 3		0 2 2	16	6 8 2.5	8	3	3 2 3	
..	..																				

Table 58. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + tertiary sand + NPK	1	5–10 10–20 30	2	3.5	9.5	8	3 3 0	0	8 10.5 5.5	3	4	4 6 4		3 3 0	11	6 2.5 8.5	4	2	4 5 4	
D-2	"	2	5–10 10–20 30	1	3.5	4.5	6	2 0 3	2	8.5 6.5 4	5	8			0 9 3	6	9 9 4	5	3		
D-3	"	3	5–10 10–20 30	2	4.5	4.5	5	0 5 0	0	13 9 5	4	4			3 0 0	4	12 8.5 5	4	2		
E-1	Ash + low moor peat + NPK	1	5–10 10–20 30	3	4	5	2	0 0 4	0	8 5 1	9	12			0 0 4	0	4.5 8 1	7	7		
E-2	"	2	5–10 10–20 30	4	4	4.5	3.5	1 4 2	0	8 4.5 2	11	15			8 4 2	0	8 2 2	6	9		
E-3	"	3	5–10 10–20 30	5	4.5	5.5	0	0 4 4	0	8 4 4.5	5	9			0 4 4	0	6.5 5 4.5	7	10		
F-1	Ash + high moor peat + NPK	1	5–10 10–20 30	5.5	5	6.5	2	0 4 0	8	7 5 2		14			5 0 0	0	10 2.5 2	5	9		–
F-2	"	2	5–10 10–20 30	3	4.5	4	6	1 0 1	0	8 4 4.5	7	15			0 7 1	0	6.5 8 4.5	7	17		
F-3	"	3	5–10 10–20 30	3	3.5	5	5.5	0 0 0	1	4 6.5 9.5	9	9			2 1 0	0	8 6 9.5	7	10		
G-1	Ash + farm manure + NPK	1	5–10 10–20 30	2	4.5	2.5	5	2 2 0	1	8 5 5	7	9			4 3 0	0	6.5 6.5 5	9	17		
G-2	"	2	5–10 10–20 30	4	4	3.5	5.5	0 0 0	3	6 2 1	5	17			1 0 0	0	5 4 1	7	9		
G-3	"	3	5–10 10–20 30	3	2	3.5	4.5	1 0 1	4	5 1 4	10	10			0 4 1	0	1 2 4	3	12		
H(K)-1	Ash + N2PK + green manure (corn)	1	5–10 10–20 30	3	3.5	4.5	3.5	0 1 0	2	4.5 1 1	5	9			2 2 0	1	6.5 2 1	6	9		
H(K)-2	"	2	5–10 10–20 30	6.5	4	4.5	5.5	0 1 4	0	6 4 4	7	8			4 2 4	0	1 4 4	5	8		
H(K)-3	"	3	5–10 10–20 30	2	3	5.5	4	0 2 0	0	10.5 8 5.5	7	6			1 0 0	2	8 5 5.5	9	11		
..	..																				

Table 58. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10 10-20 30	2	6.5	5	4.5	5 4 0	3	8 4 2.5	5	5			0 4 0	0	12 5 2.5	7	6		
I-2	"	2	5-10 10-20 30	1.5	3.5	5	4.5	0 7 1	0	9 4 5.5	7	6			6 5 1	2	8 5.5 5.5	7	7		
I-3	"	3	5-10 10-20 30	2	3.5	4.5	4.5	5 0 3	2	8.5 5.5 5.5	8	4			0 4 3	4	10.5 2.5 5.5	7	7		
0-1	Ash without fertilization till 1976 (control)	1	5-10 10-20 30	2	2	3.5	4.5	6 0 5	0	8 5.5 2.5	7	5			3 3 5	0	6 5 2.5	6	5		
0-2	"	2	5-10 10-20 30	2	2.5	3	2.5	4 1 5	0	8 0 2.5	7	4			0 3 5	0	5.5 1 2.5	7	4		
0-3	"	3	5-10 10-20 30	3	2	4	4.5	0 5 2	2	3 5 5	6	6			3 8 2	0	10.5 5 5	9	8		

Note: 1) S - Spring
a - Fall

2) Figures in col. 3
denote cultivation of:
1 - sainfoin with crown vetch
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Content of zinc in produced soils [mg/kg of soil]

Halemba

Table 59

No. of plot	Combinations of soils and fertilizers	No. of mixture	Sampling depth cm	Measured content of zinc in soils [mg/kg of soil]																	
				Fertilized plots											Plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				s	a	s	a	s	a	s	s	a	s	a	s	a	s	s	a	s	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10	95,0	115.0	72,5	89.0	46,6		84,0	86,5		60,0		23,2		106,5	232,0		100,0	
			10-20					50,0		71,0			85,0		50,0		94,0			100,0	
			30					7,2		25,9			60.0		14.6		25.5			60.0	
A-3	"	3	5-10	102.5	170.0	65.0	101.0	24,8		95.5	91,5		57.5		20.4		63,5	106.5		57,5	
			10-20					50		115.5			60.0		50		65.0			60.0	
			30					50		20.9			33.2		50		20.9			60.0	
A-4	"	4	5-10	197,5	220.0	125.0	124.0	25.6		83.0	74.5		60.0		50		210.0	94.0		110.0	
			10-20					50		71.8			60.0		50		39.4			110.0	
			30					46.6		21.9			40.0		19.0		21.9			40.0	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10	235.0	150.0	187.5	204.0	50		87.5	81.5		85.0		50		148.5	81,5		80.0	
			10-20					50		59.6			85.0		50		64.6			45.0	
			30					7.8		11.5			24.2		41.4		11.5			24.2	
B-3	"	3	5-10	245.0	255.0	180.0	188.0	7.3		88.0	141.5		95.0		50		81.0	94.0		85.0	
			10-20					50		77.0			70.0		50		46.4			80.0	
			30					11.4		18.0			27.5		13.5		18.0			27.5	
B-4	"	4	5-10	225.0	240.0	100.0	209.0	50		65.0	98.5		77.5		50		64.6	111.0		97.5	
			10-20					32.4		14.9			77.5		40.5		70.5			120.5	
			30					11.4		12.5			40.0		2.4		12.5			40.0	
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10	245.0	167.5	98.0	138.0	40.5		57.0	23.6		47.6		23.2		132.0	228.0		127.6	
			10-20					10.8		7.4			22.5		50		8.2			92.5	
			30					5.8		3.6			17.4		4.6		3.6			17.4	
C-3	"	3	5-10	235.0	217.5	171.6	202.0	18.2		7.4	30.5		40.0		27.1		140.0	106.5		40.0	
			10-20					7.8		2.1			4.6		18.8		20.6			12.6	
			30					8.5		5.2			10.0		4.6		5.2			10.0	
C-4	"	4	5-10	180.0	85.0	87.5	157.0	19.5		6.8	29.5		8.2		0.0		1.5	46.5		38.2	
			10-20					0.0		5.3			4.2		0.0		0.2			4.8	
			30					15.8		42.0			10.0		13.5		4.2			10.0	

Table 59. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D-1	Ash + bentonite + NPK	1	5-10 10-20 30	31.0	20.0	90.0	37.4	0.0 1.1 0.0		1.2 8.0 2.5	22.7		17.0 2.8 4.0		8.8 12.6 12.6		27.9 18.0 2.5	4.6		18.0 12.8 4.0	
D-2	"	2	5-10 10-20 30	22.0	22.0	24.8	23.0	0.0 0.0 0.0		0.1 41.2 10.3	1.2		2.3 0.8 1.2		10.3 6.2 8.1		12.2 4.0 10.3	22.2		18.7 16.0 1.0	
D-3	"	3	5-10 10-20 30	12.0	27.2	26.4	28.9	7.1 8.6 7.1		1.1 3.9 9.3	2.8		10.0 3.1 7.4		0.0 0.0 6.7		0.6 4.6 9.3	12.0		10.6 11.4 7.4	
E-1	Ash + low moor peat + NPK	1	5-10 10-20 30	45.0	38.0	33.0	31.9	11.4 10.0 5.0		20.9 14.3 10.7	28.3		34.6 22.9 7.8		16.8 8.9 12.0		18.3 28.0 10.7	27.3		39.2 14.6 7.8	
E-2	"	2	5-10 10-20 30	37.0	33.0	30.5	39.6	8.9 5.5 6.5		39.2 17.4 10.3	33.6		32.0 24.1 11.5		16.0 5.0 8.0		13.1 37.4 10.3	38.5		37.7 18.4 11.5	
E-3	"	3	5-10 10-20 30	50.0	40.0	26.0	26.4	6.5 5.0 6.0		11.1 12.4 9.7	27.8		35.3 20.2 10.8		2.4 8.4 8.0		23.7 9.0 9.7	29.6		21.8 18.8 10.8	
F-1	Ash + high moor peat + NPK	1	5-10 10-20 30	21.5	17.0	18.6	23.5	2.4 4.1 3.7		19.7 12.0 16.4	16.3		21.4 16.6 9.7		2.0 7.0 5.5		21.2 12.0 16.4	20.2		24.5 18.4 9.7	
F-2	"	2	5-10 10-20 30	19.5	14.5	17.8	25.5	0.0 1.5 1.1		12.8 8.2 8.4	10.5		11.5 8.4 7.1		1.8 0.7 0.0		17.9 11.2 8.4	10.0		15.7 13.5 7.1	
F-3	"	3	5-10 10-20 30	3.8	18.2	17.0	19.0	0.0 0.0 2.8		18.7 13.0 8.2	12.9		11.2 6.4 9.8		0.3 0.3 1.1		6.6 6.4 8.2	1.6		8.1 7.8 9.8	

Table 59. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
G-1	Ash + farm manure	1	5-10	1.6	4.5	17.2	10.8	0.0		15.0	12.4		9.4		2.4		14.8	17.3		9.4	
			10-20					2.0		5.2			18.8		2.4		5.4			15.7	
			30					2.4		10.6			9.1		3.2		10.6			9.1	
G-2	"	2	5-10	0.7	6.3	19.0	13.9	2.8		8.9	1.0		21.4		3.2		9.4	0.8		16.1	
			10-20					0.0		8.0			7.4		0.0		4.5			16.5	
			30					2.0		11.6			4.6		0.7		11.6			4.6	
G-3	"	3	5-10	5.6	17.0	24.5	13.2	10.7		9.4	3.8		15.7		10.0		7.0	9.5		11.2	
			10-20					6.2		6.8			4.8		5.8		5.8			12.3	
			30					5.1		5.1			5.9		5.4		5.1			5.9	
H-1	Ash + N2PK	1	5-10	22.0	17.0	25.0	20.8	9.0		12.7	25.0		37.7		15.2		24.0	18.8		33.0	
			10-20					7.1		8.2			15.7		8.6		14.7			28.7	
			30					7.8		9.0			12.3		7.1		9.0			12.3	
H-2	"	2	5-10	20.5	21.8	24.6	27.8	13.2		10.4	24.6		17.4		8.1		10.8	16.3		18.2	
			10-20					5.0		9.4			13.6		8.6		11.6			12.1	
			30					4.5		11.8			17.0		0.0		11.8			17.0	
H-3	"	3	5-10	22.0	21.0	21.2	30.0	6.6		13.6	21.7		23.0		8.6		9.0	23.6		17.4	
			10-20					10.0		9.4			12.9		18.2		11.8			16.0	
			30					5.8		10.3			11.0		6.6		10.3			11.0	
I-1	Ash + NPK	1	5-10	2.2	2.2	2.8	19.1	5.0		5.4	16.3		12.9		0.0		0.1	1.9		5.2	
			10-20					4.1		5.4			10.0		0.0		3.9			4.8	
			30					7.6		7.4			10.2		3.9		7.4			10.2	
I-2	"	2	5-10	1.6	1.6	2.4	16.1	6.0		5.4	17.8		21.0		0.0		9.0	2.8		6.4	
			10-20					9.0		7.4			13.2		0.0		3.8			6.2	
			30					6.5		6.5			6.4		7.6		6.5			6.4	
I-3	"	3	5-10	0.9	6.0	3.5	1.8	8.1		14.4	8.0		23.0		15.9		12.4	18.8		31.5	
			10-20					7.1		10.2			11.0		9.8		10.2			18.2	
			30					13.8		6.5			14.8		8.8		6.5			14.8	
0-1	Ash without fertilization till 1976 /control/	1	5-10	10.6	18.2	11.1	15.0	15.9		15.1	19.8		12.5		15.5		18.1	23.2		22.5	
			10-20					11.6		15.6			15.7		8.1		13.7			18.7	
			30					9.6		6.3			13.6		7.6		6.3			13.6	
0-2	"	2	5-10	17.0	17.0	13.3	16.6	10.0		21.2	29.0		21.5		41.0		8.8	23.6		24.8	
			10-20					11.3		11.2			12.5		15.2		13.7			20.0	
			30					5.8		8.9			13.6		13.2		8.9			13.6	
0-3	"	3	5-10	6.5	18.5	9.3	8.5	9.0		8.9	23.6		20.6		16.7		14.7	20.2		27.5	
			10-20					10.7		12.8			12.1		11.3		9.8			22.0	
			30					4.3		11.2			11.0		10.7		11.2			11.0	

Note: 1/ S = Spring a = Fall 2/ Figures in col. 3 denote cultivation of: 1/ lucerne with sweetclover, 2/ mixture of grasses with legumes
3/ lucerne with orchard grass 4/ sweetclover

Content of zinc in produced soils [mg/kg of soil]

Konin

Table 60

No. of plot	Combinations of soils and fertilizers	No. of mix-ture	Sampling depth cm	Measured content of zinc in soils [mg/kg of soil]																	
				fertilized plots											plots non-fertilized since 1977						
				1975		1976		1977		1978	1979		1980		1977		1978	1979		1980	
				a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A-2	Ash + 20 cm of fertile soil + NPK	2	5-10 10-20 30	9.7	6.4	11.4	7.2			6.2 0.1 0.1	8.0		4.8 5.0 3.5				7.6 6.0 0.1	7.1		5.2 4.8 3.5	-
A-3	"	3	5-10 10-20 30	6.8	5.6	7.0	7.4			7.6 6.0 5.9	5.4		4.3 5.2 2.4				6.0 0.2 5.9	6.2		5.2 5.2 2.4	
A-4	"	4	5-10 10-20 30	6.5	5.6	6.1	6.4			6.0 9.0 0.2	5.4		6.4 5.0 0.4				6.4 6.0 0.2	5.4		4.3 5.2 0.4	
B-2	Ash + 10 cm of fertile soil + NPK	2	5-10 10-20 30	5.8	5.6	6.8	7.4			5.1 1.5 0.2	4.2		5.5 4.8 2.6				1.5 0.2 0.2	4.6		3.5 0.5 2.6	
B-3	"	3	5-10 10-20 30	7.4	5.5	6.4	6.6			4.5 0.3 0.2	3.9		0.5 6.8 5.8				4.3 0.2 0.2	4.2		0.5 0.5 5.8	
B-4	"	4	5-10 10-20 30	5.8	6.2	6.4	6.2			5.8 0.5 0.6	5.0		5.2 2.6 0.5				1.4 0.4 0.6	3.2		5.0 4.8 0.5	
..	.. .. .																				

Table 60. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
C-2	Ash + 5 cm of fertile soil + NPK	2	5-10 10-20 30	5.5	6.6	7.1	7.8			0.2 0.2 0.2	0.3		0.5 0.5 0.8				4.0 0.2 0.2	5.4		4.0 0.7 0.8	
C-3	"	3	5-10 10-20 30	5.4	4.4	1.0	0.4			0.3 0.2 0.2	3.5		1.0 0.5 0.5				0.3 0.3 0.2	0.2		0.5 0.7 0.5	
C-4	"	4	5-10 10-20 30	7.0	4.3	6.8	2.7			0.2 0.3 0.2	0.2		5.7 4.2 0.7				0.3 0.6 0.2	0.2		0.5 0.7 0.7	
D-1	Ash + tertiary sand + NPK	1	5-10 10-20 30	1.4	1.5	1.8	1.6			0.4 0.4 0.8	0.2		2.1 1.0 0.5				0.2 0.2 0.2	0.2		0.7 0.9 0.5	
D-2	"	2	5-10 10-20 30	0.5	0.2	0.5	1.4			0.2 0.3 0.0	0.2		0.5 0.7 0.7				1.0 0.2 0.0	0.2		0.5 0.7 0.7	
D-3	"	3	5-10 10-20 30	0.5	1.0	19.3	2.2			0.9 0.2 0.0	0.2		0.9 0.5 0.5				2.0 0.0 0.0	1.0		0.7 0.7 0.5	
E-1	Ash + low moor peat + NPK	1	5-10 10-20 30	0.3	0.0	0.5	0.8			0.1 0.2 0.3	0.0		0.4 0.3 0.4				0.1 0.0 0.3	0.0		0.4 0.4 0.4	
E-2	"	2	5-10 10-20 30	0.1	0.0	0.5	0.6			0.0 0.0 0.0	0.0		0.2 0.3 0.4				0.0 0.2 0.0	0.0		0.4 0.2 0.4	
E-3	"	3	5-10 10-20 30	0.1	0.0	0.5	0.7			0.0 0.2 0.1	0.0		0.6 0.4 0.4				0.1 0.0 0.1	0.0		0.4 0.4 0.4	

Table 60. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
F-1	Ash + high moor peat + NPK	1	5-10	0.3	0.0	0.5	0.8			0.0	0.0		0.3				0.0	0.0		0.4	
			10-20							0.0			0.3				0.1			0.6	
			30							0.1			0.4				0.1			0.4	
F-2	"	2	5-10	0.2	0.0	0.5	0.4			0.1	0.0		0.4				0.1	0.0		0.4	
			10-20							0.1			0.4				0.3			0.4	
			30							0.0			0.4				0.0			0.4	
F-3	"	3	5-10	0.5	0.0	0.5	0.5			0.0	0.0		0.2				0.0	0.0		0.3	
			10-20							0.0			0.4				0.0			0.4	
			30							0.2			0.4				0.2			0.4	
G-1	Ash + farm manure + NPK	1	5-10	0.2	0.0	0.5	0.6			0.2	0.2		0.3				0.2	0.2		0.3	
			10-20							0.3			0.4				0.1			0.4	
			30							0.2			0.4				0.2			0.4	
G-2	"	2	5-10	0.3	0.0	0.5	0.4			0.3	0.2		0.4				0.2	0.2		0.4	
			10-20							0.3			0.4				0.2			0.4	
			30							0.3			0.4				0.3			0.3	
G-3	"	3	5-10	0.2	0.0	0.5	0.4			0.1	0.2		0.2				0.4	0.2		0.3	
			10-20							0.0			0.4				0.3			0.4	
			30							0.0			0.4				0.0			0.4	
H-1	Ash + N2PK + green manure /corn/	1	5-10	0.6	0.0	0.5	0.4			0.0	0.2		0.4				0.2	0.2		1.1	
			10-20							0.0			0.2				0.0			0.4	
			30							0.1			0.3				0.1			0.3	
H-2	"	2	5-10	0.2	0.0	0.5	0.2			0.1	0.2		0.4				0.2	0.2		0.2	
			10-20							0.1			0.4				0.0			0.3	
			30							0.2			0.2				0.2			0.2	
H-3	"	3	5-10	0.3	0.0	0.8	0.3			0.1	0.2		0.4				0.1	0.2		0.3	
			10-20							0.2			0.4				0.1			0.4	
			30							0.2			0.4				0.2			0.4	

Table 68. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I-1	Ash + NPK	1	5-10 10-20 30	0.2	0.0	0.5	0.3			0.0 0.0 0.2	0.2		0.4 0.4 0.2				0.1 0.0 0.2	0.2		0.4 0.4 0.2	
I-2	"	2	5-10 10-20 30	0.3	0.1	0.5	0.4			0.0 0.0 0.0	0.2		0.6 0.5 0.3				0.0 0.1 0.0	0.2		0.5 0.6 0.3	
I-3	"	3	5-10 10-20 30	0.2	0.0	0.5	0.4			0.0 0.0 0.0	0.2		0.5 0.5 0.3				0.1 0.1 0.0	0.2		0.3 0.5 0.3	
0-1	Ash without fertilization till 1976 /control/	1	5-10 10-20 30	0.5	0.0	0.5	0.8			0.0 0.0 0.0	0.1		0.8 0.6 0.6				0.2 0.1 0.0	0.2		0.5 0.5 0.6	
0-2	"	2	5-10 10-20 30	0.5	0.0	0.5	0.4			0.0 0.0 0.0	0.2		0.5 0.5 0.6				0.0 0.0 0.2	0.2		0.6 0.6 0.6	
0-3	"	3	5-10 10-20 30	0.3	0.0	0.5	0.4			0.1 0.0 0.0	0.2		0.6 0.8 0.5				0.1 0.0 0.0	0.2		0.6 0.6 0.5	

Note:1/ S = Spring   a = Fall

2/ Figures in col. 3 denote cultivation of:
1- sainfoin with crown vetch
2- mixtures of grasses with legumes
3- lucerne with orchard grass
4- sweetclover

Content of sulphur in crops and sorptive properties of ash soils
Halemba

Plants were sampled on 3 June 1980

Soil was sampled on 3 June 1980

Table 61

No. of plot	Combinations of soils and fertilizers	No. of mixture	a=plots fertilized in 1975–1980 b=plots nonfertilized in 1978–1980	Content of sulphate sulpur in crops [percent]	Analysis of soil samples					Sulphur contained in gathered crop in 1980 I = cut I II= cut II Total [kg]
					Sampling depth [cm]	Content of sulphate sulphur [mg/100 g]	Hydrolytic acidity [meq/100g]	Sum of exchangeable bases [meq/100g]	Exchangeable capacity [meq/100g]	
1	2	3	4	5	6	7	8	9	10	11
A–2	Ash + 20 cm of fertile soil + NPK	2	a	I -0.54 II-0.42	5–10 10–20 30	0.42 1.60 0.62	3.15 3.15 3.82	9.50 8.90 15.50	12.60 12.10 19.30	I 22 II 42 64
			b		5–10 10–20	0.80 1.70	4.05 2.32	9.90 19.30	14.0 21.60	
A–3	"	3	a	I -0.57 II-0.41	5–10 10–20 30	0.65 0.78 7.40	5.77 2.25 0.45	7.30 21.00 46.90	13.10 23.30 47.40	I 20 II 29 49
			b		5–10 10–20	0.74 0.80	6.37 7.12	9.60 6.80	16.00 13.90	
A–4	"	4	a	I -0.56 II-0.26	5–10 10–20 30	2.10 6.80 7.80	8.10 0.52 0.37	6.70 48.70 45.20	14.80 49.20 45.60	I 14 II 19 33
			b		5–10 10–20	0.45 1.30	5.62 6.90	12.50 8.70	18.10 15.60	
B–2	Ash + 10 cm of fertile soil + NPK	2	a	I -0.63 II-0.34	5–10 10–20 30	1.10 5.20 10.30	4.80 0.90 0.37	10.00 41.10 48.80	14.80 42.00 49.20	I 17 II 24 41
			b		5–10 10–20	0.62 4.60	3.37 0.37	3.90 48.10	7.30 48.50	
B–3	"	3	a	I -0.66 II-0.39	5–10 10–20 30	2.60 4.60 6.90	4.20 0.52 0.37	13.90 45.70 49.40	18.10 46.20 49.80	I 15 II 19 34
			b		5–10 10–20	0.62 1.50	5.62 0.97	13.30 41.50	18.90 42.50	
B–4	"	4	a	I -0.47 II-0.40	5–10 10–20 30	1.10 1.90 3.20	2.77 0.52 0.30	23.30 46.10 46.00	26.10 48.60 46.30	I 14 II 31 45
			b		5–10 10–20	0.75 0.75	3.15 4.72	23.80 17.80	27.00 22.50	

Table 61. Continued

1	2	3	4	5	6	7	8	9	10	11
C-2	Ash + 5 cm of fertile soil + NPK	2	a	I -0.89 II-0.21	5-10 10-20 30	5.60 8.80 9.20	0.45 0.07 0.22	48.60 49.50 49.40	49.10 49.60 49.60	I 18 II 16 34
			b		5-10 10-20	1.70 3.70	1.12 0.30	35.70 48.40	36.80 48.70	
C-3	"	3	a	I -0.39 II-0.38	5-10 10-20 30	5.80 8.10 8.30	0.22 0.07 0.07	49.20 48.90 49.20	49.40 49.00 49.30	I 5 II 31 36
			b		5-10 10-20	7.00 6.70	0.15 0.15	49.00 49.10	49.20 49.30	
C-4	"	4	a	I -0.88 II-0.31	5-10 10-20 30	10.40 12.60 42.00	0.15 0.15 0.07	49.30 48.80 49.00	49.50 49.00 49.10	I 27 II 18 45
			b		5-10 10-20	8.10 7.10	0.15 0.07	48.90 48.60	49.10 48.70	
D-1	Ash + bentonite + NPK	1	a	I -0.95 II-0.39	5-10 10-20 30	10.50 10.50 10.10	0.15 0.07 0.07	49.40 49.10 48.80	49.60 49.20 48.90	I 25 II 23 48
			b		5-10 10-20	7.30 8.80	0.22 0.22	48.20 48.60	48.40 48.80	
D-2	"	2	a	I -0.81 II-0.20	5-10 10-20 30	8.30 11.50 22.80	0.07 0.07 0.07	48.70 48.70 49.00	48.80 48.80 49.10	I 20 II 10 30
			b		5-10 10-20	8.85 8.90	0.22 0.15	49.40 49.20	49.60 49.40	
D-3	"	3	a	I -0.74 II-0.32	5-10 10-20 30	8.80 8.30 8.20	0.07 0.07 0.07	49.00 48.50 48.90	49.10 48.60 49.00	I 12 II 19 31
			b		5-10 10-20	7.80 10.50	0.07 0.07	49.30 49.30	49.40 49.40	
E-1	Ash + low moor peat + NPK	1	a	I -0.70 II-0.36	5-10 10-20 30	5.40 8.60 19.00	0.30 0.30 0.22	47.30 47.70 48.70	47,60 48.00 48.90	I 17 II 23 40
			b		5-10 10-20	5.90 9.60	C.45 0.30	47.50 48.80	48.00 49.10	
E-2	"	2	a	I -0.55 II-0.54	5-10 10-20 30	6.60 9.20 9.40	0.37 0.30 0 22	48.90 49.00 49.10	49.30 49.30 49.30	I 12 II 33 45
			b		5-10 10-20	8.00 8.60	0.30 0.30	48.40 49.00	48.70 49.30	
E-3	"	3	a	I -0.80 II-0.18	5-10 10-20 30	6.60 7.70 9.40	0.52 0.37 0.22	48.00 48.80 46.30	48.50 49.20 46.50	I 15 II 13 28
			b	–	5-10 10-20	8.00 8.00	0.37 0.22	48.70 48.20	49.10 48.40	

Table 61. Continued

1	2	3	4	5	6	7	8	9	10	11
F-1	Ash + high moor peat + NPK	1	a	I -0.68 II-0.41	5-10 10-20 30	5.40 6.60 16.60	0.30 0.22 0.15	49.00 49.00 49.10	49.30 49.20 49.30	I 21 II 24 45
			b		5-10 10-20	9.00 8.30	0.22 0.30	49.10 48.20	49.30 48.50	
F-2	"	2	a	I -0.48 II-0.19	5-10 10-20 30	6.60 7.20 6.90	0.07 0.15 0.07	49.00 49.00 49.10	49.10 49.20 49.20	I 9 II 11 20
			b		5-10 10-20	6.60 6.50	0.15 0.15	49.40 49.10	49.60 49.30	
F-3	"	3	a	I -0.23 II-0.41	5-10 10-20 30	6.10 5.20 6.90	0.07 0.07 0.07	48.50 48.50 48.10	48.60 48.60 48.20	I 4 II 25 29
			b		5-10 10-20	4.20 4.50	0.15 0.07	48.50 48.70	48.70 48.80	
G-1	Ash + farm manure + NPK	1	a	I -0.84 II-0.26	5-10 10-20 30	5.40 6.10 6.70	0.15 0.15 0.07	48.40 48.90 48.70	48.60 49.10 48.80	I 19 II 15 34
			b		5-10 10-20	6.70 6.50	0.15 0.07	48.60 49.00	48.80 49.10	
G-2	"	2	a	I -0.65 II-0.24	5-10 10-20 30	9.90 46.00 9.00	0.15 0.15 0.07	48.80 48.60 48.60	49.00 48.80 48.70	I 11 II 15 26
			b		5-10 10-20	6.70 6.50	0.22 0.07	48.80 49.00	49.00 49.10	
G-3	"	3	a	I -0.84 II-0.41	5-10 10-20 30	6.80 7.20 6.50	0.15 0.07 0.07	48.80 48.20 48.50	49.00 48.30 48.60	I 12 II 26 38
			b		5-10 10-20	5.80 5.60	0.15 0.22	49.20 48.70	49.40 48.90	
H-1	Ash + N2PK	1	a	I -0.84 II-0.52	5-10 10-20 30	5.60 8.00 7.10	0.22 0.15 0.15	47.50 49.00 48.90	47.70 49.20 49.10	I 16 II 37 53
			b		5-10 10-20	5.40 7.40	0.15 0.15	48.80 48.60	49.00 48.80	
H-2	"	2	a	I -0.55 II-0.19	5-10 10-20 30	9.10 16.00 18.00	0.15 0.15 0.07	48.90 49.00 48.80	49.10 49.20 48.90	I 11 II 14 25
			b		5-10 10-20	9.60 6.90	0.30 0.15	48.20 48.20	48.50 48.40	
H-3	"	3	a	I -0.76 II-0.21	5-10 10-20 30	6.20 7.20 7.10	0.22 0.15 0.15	48.80 48.90 49.00	49.00 49.10 49.20	I 10 II 14 24
			b		5-10 10-20	6.90 6.40	0.22 0.15	48.80 48.70	49.00 48.90	

Table 61. Continued

1	2	3	4	5	6	7	8	9	10	11
I-1	Ash + NPK	1	a	I -0.29 II-0.31	5-10 10-20 30	7.80 8.80 8.70	0.15 0.15 0.07	49.40 49.20 49.50	49.60 49.40 49.60	I 9 II 16 25
			b		5-10 10-20	6.00 5.50	0.07 0.07	49.10 49.20	49.20 49.30	
I-2	"	2	a	I -0.80 II-0.11	5-10 10-20 30	6.50 7.40 8.20	0.22 0.22 0.15	49.60 49.50 49.30	49.80 49.70 49.50	I 18 II 6 24
			b		5-10 10-20	7.50 5.70	0.07 0.07	49.30 49.40	49.40 49.50	
I-3	"	3	a	I -0.81 II-0.31	5-10 10-20 30	5.70 5.10 5.80	0.22 0.15 0.15	49.40 49.40 49.30	49.60 49.60 49.50	I 15 II 19 34
			b		5-10 10-20	7.60 7.00	0.22 0.22	49.50 49.40	49.70 49.60	
0-1	Ash without fertilization till 1976 /control/	1	a	I -0.37 II-0.32	5-10 10-20 30	5.80 7.80 10.40	0.30 0.30 0.15	45.10 49.30 49.40	45.40 49.60 49.60	I 8 II 21 29
			b	I-0.65	5-10 10-20	6.00 8.35	0.15 0.15	49.40 49.10	49.60 49.30	I 6 II 5 11
0-2	"	2	a	I -0.89 II-0.19	5-10 10-20 30	7.40 8.80 7.00	0.30 0.22 0.07	48.50 48.60 48.90	48.80 48.80 49.00	I 16 II 13 19
			b	I -0.78	5-10 10-20	8.40 6.30	0.30 0.15	48.70 48.40	49.00 48.60	I 3 II 6 9
0-3	"	3	a	I -0.71 II-0.28	5-10 10-20 30	8.00 7.80 13.40	0.22 0.22 0.22	48.80 49.00 47.80	49.00 49.20 48.00	I 11 II 19 30
			b	I -0.78	5-10 10-20	6.70 8.50	0.30 0.22	48.70 48.80	49.00 49.00	I 4 II 3 7

Note: Figures in col. 3 denote cultivation of:
1 - lucerne with sweetclover
2 - mixture of grasses with legumes
3 - lucerne with orchard grass
4 - sweetclover

Content of sulphur in crops and sorptive properties of ash soils

Konin

Plants were sampled on 6 June 1980 /I crop/ and on 14 August 1980 /II crop/

Soil was sampled on 6 June 1980

Table 62

No. of plot	Combinations of soils and fertilizers	No. of mixture	a=plots fertilized in 1975–1980 b=plots non-fertilized in 1978–1980	Content of sulphate sulphur in yields [percent]	Anylyses of soil samples					Sulphur contained in gathered crop in 1980 I = cut I II = cut II Total [kg]
					Sampling depth [cm]	content of sulphate sulphur [mg/100g]	hydrolytic acidity [meq/100g]	sum of exchangeable bases [meq/100g]	Exchangeable capacity [meq/100g]	
1	2	3	4	5	6	7	8	9	10	11
A-2	Ash + 20 cm of fertile soil + NPK	2	a	I - 0.23 II-0.35	5-10 10-20 30	1.50 1.10 28.00	0.22 0.30 0.22	30.70 30.80 45.10	30.90 31.10 45.30	I 11 II 29 40
			b		5-10 10-20	2.60 1.60	0.22 0.30	29.70 30.10	29.90 30.40	
A-3	"	3	a	I -0.10 II-0.36	5-10 10-20 30	3.50 1.80 71.50	0.45 0.37 0.30	31.50 32.40 48.50	32.00 32.80 48.80	I 4 II 29 33
			b		5-10 10-20	6.70 15.00	0.30 0.22	43.40 44.10	43.70 44.80	
A-4	"	4	a	I -0.70 II-0.43	5-10 10-20 30	3.30 6.40 78.00	0.30 0.30 0.22	42.10 41.60 46.00	42.40 41.90 46.20	I 26 II 34 60
			b		5-10 10-20	20.50 9.00	0.30 0.30	48.60 46.10	48.90 46.40	

Table 62. Continued

1	2	3	4	5	6	7	8	9	10	11
B-2	Ash + 10 cm of fertile soil + NPK	2	a	I -0.28 II-0.3	5-10 10-20 30	9.75 11.00 54.50	0.30 0.30 0.22	43.30 48.10 48.40	43.60 48.40 48.60	I 16 II 21 37
			b		5-10 10-20	12.70 79.50	0.30 0.37	46.60 47.10	46.90 47.50	
B-3	"	3	a	I -0.20 II-0.35	5-10 10-20 30	7.20 4.40 13.20	0.30 0.37 0.30	34.70 36.20 47.50	35.00 36.60 47.80	I 10 II 36 46
			b		5-10 10-20	65.00 165.00	0.37 0.37	46.20 47.60	46.60 48.00	
B-4	"	4	a	I -0.30 II-0.48	5-10 10-20 30	24.50 29.50 98.00	0.30 0.30 0.30	48.90 46.30 40.40	49.20 46.60 40.70	I 14 II 65 79
			b		5-10 10-20	12.60 4.40	0.37 0.30	36.70 47.00	37.10 47.30	
C-2	Ash + 5 cm of fertile soil + NPK	2	a	I -0.55 II-0.18	5-10 10-20 30	33.50 90.00 102.00	0.30 0.37 0.30	46.30 47.00 49.00	46.60 47.40 49.30	I 25 II 12 37
			b		5-10 10-20	21.50 68.50	0.30 0.37	48.10 48.60	48.40 49.00	
C-3	"	3	a	I -0.20 II-0.38	5-10 10-20 30	31.70 45.00 92.50	0.37 0.37 0.37	48.20 47.50 47.70	48.60 47.90 48.10	I 7 II 34 41
			b		5-10 10-20	98.00 28.50	0.37 0.37	47.70 48.00	48.10 48.40	
C-4	"	4	a	I -0.13 II-0.41	5-10 10-20 30	11.50 32.50 100.00	0.30 0.30 0.30	48.10 48.20 48.00	48.40 48.50 48.30	I 6 II 22 28
			b		5-10 10-20	100.00 27.00	0.30 0.37	48.20 48.00	48.50 48.40	
D-1	Ash + tertiary sand + NPK	1	a	I -0.31 II-0.34	5-10 10-20 30	37.50 48.10 20.00	0.30 0.37 0.37	49.00 48.10 48.20	49.30 48.50 48.60	I 11 II 36 47
			b		5-10 10-20	88.70 25.00	0.37 0.37	48.10 48.00	48.50 48.40	
D-2	"	2	a	I -0.17 II-0.36	5-10 10-20 30	41.20 12.50 37.50	0.22 0.15 0.22	48.10 47.20 47.90	48.30 47.40 48.10	I 8 II 39 47
			b		5-10 10-20	83.70 162.50	0.22 0.22	47.00 45.80	47.20 46.00	
D-3	"	3	a	I -0.02 II-0.50	5-10 10-20 30	77.50 230.00 248.70	0.30 0.22 0.22	44.90 48.10 48.40	45.20 48.30 48.60	I 1 II 54 55
			b		5-10 10-20	62.50 81.20	0.22 0.22	49.10 47.80	49.30 48.00	

Table 62. Continued

1	2	3	4	5	6	7	8	9	10	11
E-1	Ash + low moor peat + NPK	1	a	I -0.03 II-0.47	5-10 10-20 30	81.20 108.70 138.70	0.22 0.22 0.30	47.50 47.90 46.40	47.70 48.10 46.70	I 1 II 49 50
			b		5-10 10-20	90.00 125.00	0.30 0.30	46.80 47.10	47.10 47.40	
E-2	"	2	a	I -0.12 II-0.22	5-10 10-20 30	106.20 146.20 153.70	0.22 0.30 0.30	48.40 47.20 48.10	48.60 47.50 48.40	I 7 II 25 32
			b		5-10 10-20	132.50 67.50	0.22 0.22	48.60 48.70	48.80 48.90	
E-3	"	3	a	I -0.06 II-0.54	5-10 10-20 30	136.70 232.50 150.00	0.22 0.22 0.15	47.10 47.30 48.50	47.30 47.50 48.70	I 3 II 46 49
			b		5-10 10-20	65.00 125.00	0.15 0.22	48.90 48.10	49.10 48.30	
F-1	Ash + high moor peat + NPK	1	a	I -0.10 II-0.56	5-20 20-30 30	150.00 225.00 235.00	0.37 0.30 0.30	46.10 45.80 46.20	46.50 46.10 46.50	I 3 II 41 44
			b		5-10 10-20	115.00 200.00	0.37 0.22	45.90 46.40	46.30 46.60	
F-2	"	2	a	I -0.15 II-0.58	5-10 10-20 30	108.70 170.00 240.00	0.22 0.22 0.15	47.50 48.10 48.80	47.70 48.30 49.00	I 7 II 68 75
			b		5-10 10-20	170.00 206.50	0.15 0.22	48.70 48.40	48.90 48.60	
F-3	"	3	a	I -0.60 II-0.54	5-10 10-20 30	173.70 220.00 225.00	0.30 0.22 0.22	48.10 48.40 47.90	48.40 48.60 48.10	I 28 II 47 75
			b		5-10 10-20	151.20 220.00	0.30 0.30	46.60 47.20	46.90 47.50	
G-1	Ash + farm manure + NPK	1	a	I -0.02 II-0.53	5-10 10-20 30	180.00 145.00 232.50	0.30 0.30 0.15	47.10 47.30 48.70	47.40 47.60 48.90	I 1 II 46 47
			b		5-10 10-20	212.50 147.50	0,22 0.15	48.10 48.40	48.30 48.60	
G-2	"	2	a	I -0.17 II-0.36	5-10 10-20 30	155.00 171.20 232,50	0.30 0.30 0.22	47.30 46.50 46.60	47.60 46.80 46.80	I 7 II 30 37
			b		5-10 10-20	132.50 145.00	0.22 0.22	48.10 48.40	48.30 48.60	
G-3	"	3	a	I -0.10 II-0.44	5-10 10-20 30	157.50 242.50 160.00	0.22 0.22 0.22	47.40 47.30 48.10	47.60 47.50 48.30	I 3 II 30 33
			b		5-10 10-20	151.20 155.00	0.15 0.15	48.50 48.70	48.70 48.90	

Table 62. Continued

1	2	3	4	5	6	7	8	9	10	11
H/K/-1	Ash + N2PK + green manure /corn/	1	a	I -0.02 II-0.44	5-10 10-20 30	170.00 177.50 240.00	0.30 0.30 0.22	47.50 47.00 47.30	47.80 47.30 47.50	I 1 II 35 36
			b		5-10 10-20	132.00 137.50	0.15 0.30	48.10 46.20	48.30 46.50	
H/K/-2	"	2	a	I -0.22 II-0.51	5-10 10-20 30	83.70 167.50 222.50	0.30 0.22 0.22	48.10 48.40 48.40	48.40 48.60 48.60	I 9 II 51 60
			b		5-10 10-20	98.70 150.00	0.22 0.22	48.20 48.30	48.40 48.50	
H/K/-3	"	3	a	I -0.08 II-0.61	5-10 10-20 30	211.20 165.00 240.00	0.30 0.30 0.30	46.30 46.90 46.50	46.60 47.20 46.80	I 3 II 49 52
			b		5-10 10-20	127.00 165.00	0.22 0.30	47.60 48.20	47.80 48.50	
I-1	Ash + NPK	1	a	I -0.02 II-0.48	5-10 10-20 30	123.70 191.20 137.50	0.15 0.30 0.30	48.10 46.40 47.20	48.30 46.70 47.50	I 1 II 41 42
			b		5-10 10-20	122.50 167.50	0.30 0.22	47.10 48.10	47.40 48.30	
I-2	"	2	a	I -0.08 II-0.47	5-10 10-20 30	165.00 240.00 500.00	0.22 0.22 0.30	47.50 47.70 46.40	47.70 47.90 46.70	I 4 II 43 47
			b		5-10 10-20	162.50 197.50	0.30 0.30	46.40 46.60	46.70 46.90	
I-3	"	3	a	I -0.10 II-0.26	5-10 10-20 30	127.00 190.00 222.50	0.30 0.30 0.22	46.50 47.60 48.10	46.80 47.90 46.30	I 4 II 19 23
			b	I -0.50	5-10 10-20	212.50 250.00	0.30 0.22	47.40 47.90	47.70 48.10	
0-1	Ash without fertilization till 1976 /control/	1	a	I -0.80 II-0.28	5-10 10-20 30	137.50 152.50 82.50	0.15 0.22 0.15	47.90 47.50 48.10	48.10 47.70 48.30	I 26 II 26 52
			b		5-10 10-20	110.00 122.00	0.22 0.22	48.20 47.70	48.40 47.90	
0-2	"	2	a	I -0.20 II-0.36	5-10 10-20 30	163.10 167.50 187.50	0.22 0.22 0.15	47.20 48.10 48.40	47.40 48.30 48.60	I 7 II 37 44
			b	I -0.01	5-10 10-20	142.00 193.70	0.22 0.22	48.10 48.10	48.30 48.30	
0-3	"	3	a	I -0.20 II-0.52	5-10 10-20 30	170.00 116.20 135.00	0.15 0.30 0.15	48.30 47.70 48.10	48.50 48.00 48.30	I 9 II 32 41
			b	I -0.06	5-10 10-20	100.00 170.00	0.22 0.22	48.20 47.70	48.40 47.90	

Table 62. Continued

Note:

Figures in col.3 denote cultivation of:

1 - sainforn with crown vetch

2 - mixture of grasses with legumes

3 - lucerne with orchard grass

4 - sweetclover

Balance of P_2O_5 in formed ash soils

HALEMBA - fertilized plots

Table 63

Numbers of plots	Soil richness at the beginning of experiments kg/ha	Fertilization in years 1975-1980 kg/ha	Total of col.2+3 kg/ha	Gathered in yields of 1975-1980 kg/ha	Soil richness in final period of experiments kg/ha	Total of col.5+6 kg/ha	Losses /-/ or surpluses of P_2O_5 /+/ kg/ha
1	2	3	4	5	6	7	8
A-2	354	530	884	250	180	430	- 454
A-3	138	530	668	173	108	281	- 387
A-4	660	530	1190	196	435	631	- 559
B-2	234	530	764	191	126	317	- 447
B-3	495	530	1025	144	258	402	- 623
B-4	375	530	905	171	300	471	- 434
C-2	420	530	950	150	630	780	- 170
C-3	750	530	1280	116	750	866	- 414
C-4	1050	530	1580	123	990	1113	- 467
D-1	2250	530	2780	136	1320	1456	-1324
D-2	1920	530	2450	89	435	524	-1926
D-3	1770	530	2300	89	630	719	-1581
E-1	2655	530	3185	209	3435	3644	+ 459
E-2	1680	530	2210	145	2250	2395	+ 185
E-3	1680	530	2210	128	2865	2993	+ 783
F-1	1635	530	2165	133	1875	2008	- 157
F-2	1590	530	2120	90	1590	1680	- 440
F-3	1125	530	1655	75	1290	1365	- 290
G-1	1095	530	1625	89	1590	1679	+ 54
G-2	573	530	1103	88	1455	1543	+ 440
G-3	1245	530	1775	95	1830	1925	+ 150
H-1	2250	530	2780	122	2250	2372	- 408
H-2	1725	530	2255	121	1680	1801	- 454
H-3	2175	530	2705	116	1830	1946	- 759
I-1	1290	530	1820	96	1245	1341	- 479
I-2	1380	530	1910	93	573	666	-1244
I-3	930	530	1460	90	1635	1725	+ 265
O-1	1290	530	1820	119	1590	1709	- 111
O-2	1545	530	2075	96	1680	1776	- 299
O-3	1095	530	1625	106	1455	1561	- 64

Balance of P_2O_5 in formed ash soils

K O N I N - fertilized plots

Table 64

Numbers of plots	Soil richness at the beginning of experiments kg/ha	Fertilization in years 1975-1980 kg/ha	Total of col. 2+3 kg/ha	Gathered in yields of 1975-1980 kg/ha	Soil richness in final period of experiments kg/ha	Total of col.5+6 kg/ha	Losses of surpluses of P_2O_5 kg/ha
1	2	3	4	5	6	7	8
A-2	69	530	599	228	75	303	- 296
A-3	75	530	605	220	150	370	- 235
A-4	270	530	800	150	60	210	- 590
B-2	90	530	620	188	309	497	- 125
B-3	75	530	605	186	138	324	- 281
B-4	240	530	770	131	114	244	- 523
C-2	2475	530	3005	154	336	490	- 2515
C-3	1095	530	1625	142	1245	1387	- 238
C-4	1680	530	2210	104	1170	1274	- 936
D-1	1770	530	2300	66	1770	1836	- 464
D-2	1680	530	2210	107	1635	1742	- 468
D-3	2250	530	2780	101	1050	1151	- 1629
E-1	3600	530	4130	44	3300	3344	- 786
E-2	2040	530	2570	121	2865	2986	+ 416
E-3	2250	530	2780	117	2040	2157	- 623
F-1	1500	530	2030	68	2040	2108	+ 78
F-2	1350	530	1880	103	1830	1933	+ 53
F-3	1680	530	2210	108	1170	1278	- 932
G-1	990	530	1520	81	1770	1851	+ 331
G-2	1125	530	1655	142	1455	1597	- 58
G-3	1800	530	2330	138	930	1068	- 1262
H-1	1770	530	2300	63	2175	2238	- 62
H-2	1725	530	2255	112	1680	1792	- 463
H-3	2250	530	2780	103	1635	1738	- 1042
I-1	780	530	1310	70	660	730	- 580
I-2	840	530	1370	98	780	878	- 492
I-3	990	530	1520	73	2175	2248	+ 728
O-1	1635	530	2165	49	1635	1684	- 481
O-2	1635	530	2165	60	2250	2310	+ 145
O-3	1455	530	1985	80	2310	2390	+ 405

Balance of K_2O in formed ash soils

HALEMBA - fertilized plots

Table 65

Numbers of plots	Soil richness at the beginning of experiments kg/ha	Fertilization in years 1975-1979 kg/ha	Total kg/ha	Gathered in yields of 1975-79 kg/ha	Soil richness in final period of experiments kg/ha	Losses /-/ or surpluses /+/ kg/ha	Notes
1	2	3	4	5	6	7	8
A-2	345	620	965	708	270	+ 13	
A-3	195	620	815	809	165	+ 59	
A-4	495	620	1115	497	143	-475	
B-2	525	620	1145	623	180	-342	
B-3	525	620	1145	716	195	-234	
B-4	615	620	1235	507	90	-638	
C-2	540	620	1160	599	375	-186	
C-3	570	620	1190	496	330	-364	
C-4	600	620	1220	421	555	-244	
D-1	1080	620	1700	299	555	-846	
D-2	1290	620	1910	500	465	-945	
D-3	870	620	1490	482	285	-723	
E-1	705	620	1325	299	615	-411	
E-2	600	620	1220	638	645	+ 63	
E-3	540	620	1160	668	585	+ 93	
F-1	480	620	1100	352	285	-463	
F-2	450	620	1070	625	630	+185	
F-3	405	620	1025	643	510	+128	
G-1	615	620	1235	449	795	+ 9	
G-2	720	620	1340	819	420	-101	
G-3	900	620	1520	880	525	-115	
H-1	900	620	1520	368	660	-492	
H-2	675	620	1295	671	825	+201	
H-3	660	620	1280	728	345	-207	
I-1	555	620	1175	398	375	-402	
I-2	660	620	1280	635	315	-330	
I-3	450	620	1070	602	450	- 18	
O-1	360	590	950	275	660	- 15	
O-2	375	590	965	360	420	-185	
O-3	315	590	905	663	540	+298	

Balance of K_2O in formed ash soils

KONIN - fertilized plots

Table 66

Numbers of plots	Soil richness at the beginning of experiments kg/ha	Fertilization in years 1975-1979 kg/ha	Total kg/ha	Gathered in yields of 1975-1979 kg/ha	Soil richness in final period of experiments kg/ha	Losses /-/ or surpluses /+/ kg/ha	Notes
1	2	3	4	5	6	7	8
A-2	285	430	715	611	150	+ 46	
A-3	225	430	655	578	150	+ 73	
A-4	285	430	715	378	270	- 67	
B-2	300	430	730	493	240	+ 3	
B-3	225	430	655	545	105	- 5	
B-4	360	430	790	349	225	- 216	
C-2	255	430	685	441	210	- 34	
C-3	375	430	805	393	90	- 322	
C-4	675	430	1105	267	330	- 508	
D-1	330	430	760	199	165	- 396	
D-2	420	430	850	347	150	- 353	
D-3	600	430	1030	362	75	- 593	
E-1	780	430	1210	202	120	- 888	
E-2	885	430	1315	440	435	- 440	
E-3	915	430	1345	492	150	- 703	
F-1	1065	430	1495	246	300	- 949	
F-2	555	430	985	447	255	- 283	
F-3	930	430	1360	455	435	- 470	
G-1	1650	430	2080	324	585	-1171	
G-2	1200	430	1630	680	225	- 725	
G-3	1860	430	2290	745	315	-1230	
H-1	720	430	1150	262	510	- 378	
H-2	600	430	1030	505	525	0	
H-3	765	430	1195	572	240	- 383	
I-1	990	430	1420	264	270	- 886	
I-2	780	430	1210	462	525	- 223	
I-3	615	430	1045	431	315	- 299	
O-1	990	430	1390	177	360	- 853	
O-2	975	400	1375	220	315	- 840	
O-3	600	400	1000	496	660	+ 156	